Skyways

Flight Operations
•
Engineering
•
Management

YWAYS Round Table:
eration Problems of
rboprop-Turbojet

•

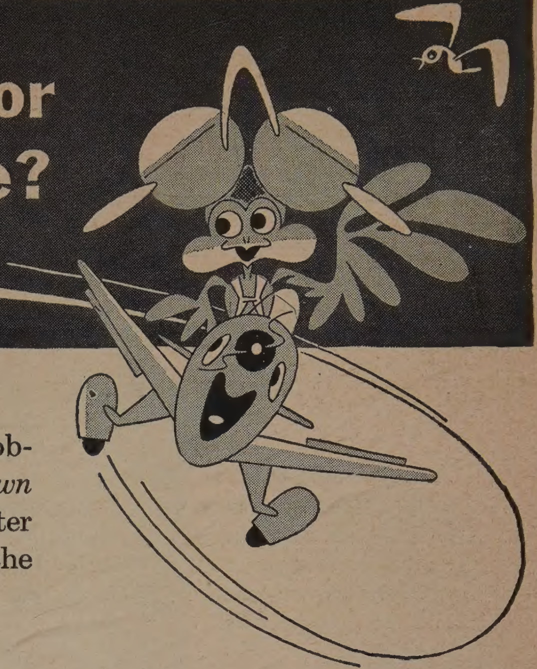
ot's Report:
o Commander

•

DC-3 with
Boost

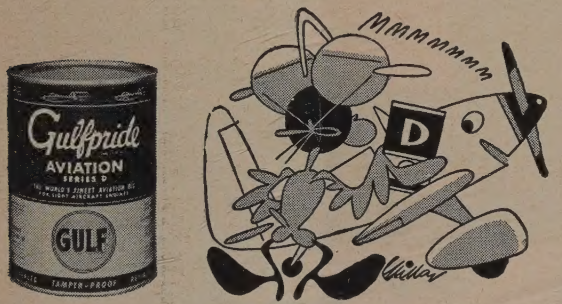
/. 1952 35c

What's the right oil for *your* airplane engine?



You've heard so much about aircraft oils you probably want to know which one is best for *your own engine*. Good idea. You'll fly more safely, no matter what type of engine your plane has, if you use the *right* oil for your engine type. For example:

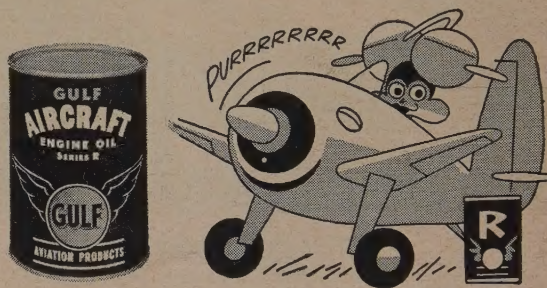
Horizontally opposed engines need Gulfpride Aviation Oil Series-D!



Here's the world's finest detergent-dispersant aviation oil. It's made *exclusively* for use in horizontally opposed engines. Because it is put through Gulf's exclusive Alchlor Process to remove extra amounts of carbon-and-sludge formers, Gulfpride Aviation Oil, Series-D, prevents ring and valve sticking . . . maintains a cleaner, better operating condition longer.

Actually, users have increased periods between engine overhauls as much as 100% with this great oil!

For radial engines or where a detergent oil is not desired, use Gulf Aircraft Engine Oil Series-R!



Assures superior performance in radial engines. Especially recommended for maximum operating periods between overhauls, it may also be used in horizontally opposed engines when operating conditions do not require a detergent oil.

A fine-quality, non-detergent, straight mineral oil, Gulf Aircraft Engine Oil, Series-R, is highly effective in retarding sludge formation. Maintains its body at high operating temperatures, too.

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La Mesa, California

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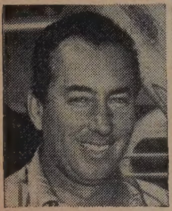
Westerners set pace for flying clubs



Mike L. May, manager of La Pressa Air Service, Inc., is one of the many Western airport dealers who specialize in the light planes that are the pace-setters for the air age. He says:

"**With three active** flying clubs, we regularly service close to 40 light planes here at La Pressa. In addition, we have many visiting aircraft. That's one good reason why we carry Chevron 80/87 Aviation Gasoline and RPM Aviation Oil. When light plane owners get together, they like to compare the performance and economy of aviation products—and again and again we find they vote Chevron 80/87 and 'RPM' tops on both counts. With RPM Aviation Oil, for example, five of our engines went to 1500 hours before major overhaul!

"**Another major economy** factor with 'RPM' shows up in longer engine life. On four light engines, with an average logged time of 1850 hours, we found wear was .002 or less in each case . . . and that's hard to beat! Our pilots have found they get the same fine performance record with Chevron 80/87 Aviation Gasoline. We get a lot of hot weather flying here in the West, and that's where Chevron 80/87 proves its worth in take-off power and economical cruising. We've found it's the best all-round light plane aviation gasoline."

T.M'S "RPM", "CHEVRON," REG. U.S. PAT. OFF.

TIP OF THE MONTH

Mike L. May says: "When you're making a short local flight and don't feel it necessary to file a flight plan—always advise your airport manager where you are going and when you will return. A few words may save your life."

CHEVRON AVIATION GASOLINE

RPM AVIATION OIL

STANDARD OIL COMPANY OF CALIFORNIA

Skyways

NOVEMBER 1952

Flight Operations • Engineering • Management

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COVER: The red and white Aero Commander is latest model of this five/six-place executive ship.

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Stall Talk

Gentlemen:

Here are my thoughts regarding the stall problem. I'll use a hypothetical case which may help to clarify the thinking on this.

A plane is hovering at its power-on stalling speed of 40 mph (Calibrated-Indicated airspeed) in a 40-mph headwind. To give the pilot in this plane a fighting chance, I am placing the ship at 3,000 feet pressure altitude, and the temperature at this altitude is -15°C. Under these conditions, a Cal. IAS of 40 mph equals a TAS of 40 mph. The plane's groundspeed in this case is obviously zero, but who cares? We are primarily concerned with our speed through an air mass whenever we are airborne. If the plane in this case were experiencing an 80-mph headwind, its TAS relative to the moving air mass would still be 40 mph even though the pilot found himself moving rearward over the surface of the earth. The dynamic forces acting upon the airfoil, producing flight, are exactly the same in this latter instance as they would be if the plane were making a TAS of 40 mph in still air, in which case his groundspeed would also be 40 mph, but forward.

Let's return to the original situation in which we have the plane at 3,000 feet, hovering at its absolute minimum flying speed of 40 mph in a headwind of 40 mph with groundspeed zero. Due to some freak of nature, the wind velocity suddenly drops from 40 mph to 0 before the pilot can bat an eyelash. Or, to put it another way, the moving air mass suddenly becomes a still air mass relative to the earth's surface. Well, here we are at 3,000 feet with zero IAS, zero TAS and zero GS, and the flight sustaining forces acting upon the airfoil also suddenly zero. Mr. Newton would be highly disappointed if gravity didn't take over at this point. And since I am inclined to concur with Mr. Newton, I would strongly recommend that Dilbert get his nose down but quick, and jam that throttle to the bulkhead if he ever hopes to regain flying speed.

During this improbable situation, the thrust produced by the engine and prop had been constant and barely sufficient to produce the minimum TAS of 40 mph necessary to maintain flight in a uniform air mass. When this moving air mass suddenly became an absolutely still air mass, Dilbert found that his airspeed meter dropped from 40 mph to 0 instantly, and his plane was then 40 mph below its absolute minimum power-on flying speed or, if you wish, the plane was then 40 mph below its power-on stalling speed. It will take a little time for Dilbert's plane to regain flying speed in the new static air mass, and he will no doubt consume a good portion of the 3,000 feet of altitude before he again gets flying speed relative to the new air mass in which he suddenly finds himself. With the aid of gravity and full thrust from its engine, Dilbert's plane eventually will overcome the inertia of its static condition existing immediately after the air mass becomes still.

R. L. Kruse

Copilot & Navigator
Pan American World Airways
LaGuardia Field, New York

Gentlemen:

By one of those zillion-to-one coincidences, I actually saw the answer to the question of wind, then no wind and a stall condition. It may be impossible for the wind to change instantaneously, but I really saw it change from a headwind of 15 mph to a tailwind of at least 40 mph in the time it takes to wink. The airplane descended at an almost vertical angle and did not roll its own length, although the pilot did get the throttle opened wide before he hit. The drop was about 75 feet. Contact with the ground was three-point, probably due to wide-open throttle.

Several other instructors witnessed the incident, and all agreed as to what happened, but I was the only one in the ideal position to observe everything most accurately.

Al Knouff

AOPA #3892
Tucson, Arizona

And the letters continue to come in favoring Mr. H. M. Saint's contention (August issue) that the plane would have to dart forward with reference to the ground the instant the wind dropped to 0, to recover the lost airspeed and to maintain the dynamic forces producing flight.—Ed.

Carburetor Icing

Gentlemen:

I would appreciate your opinion as to a possible cause of engine failure.

I had been cruising on a steady course at an altitude of 1500 feet, airspeed 85 mph for 30 minutes. It was a clear day, air temp was about 75° F. Suddenly the engine began sputtering and missing. After about 30 seconds, it stopped entirely. There was sufficient fuel in the tanks, no cut-off valves were shut, and switching magnetos had no effect. The plane was lost at sea. Does carburetor icing seem at all likely in this case?

R. H. Pierce

USS Queenfish
FPO San Francisco, Cal.

In our opinion, carburetor icing is a definite possibility. Carburetor ice can occur on clear days when the atmospheric temperature is between 30° and 75°F if the relative humidity is high. However, our's is just an opinion. There are many other factors that, if known, might dictate another cause.—Ed.

"SEE YOU AT THE POLLS!"

"SEE YOU AT THE POLLS!"

"SEE YOU AT THE POLLS!"

Nobody knows for sure how it started — this line about "See you at the Polls!" we're hearing all over these days.

Best explanation seems to be that it came from that state candidate out west . . . His opponent in a debate got all riled up and challenged him to fight it out in the alley.

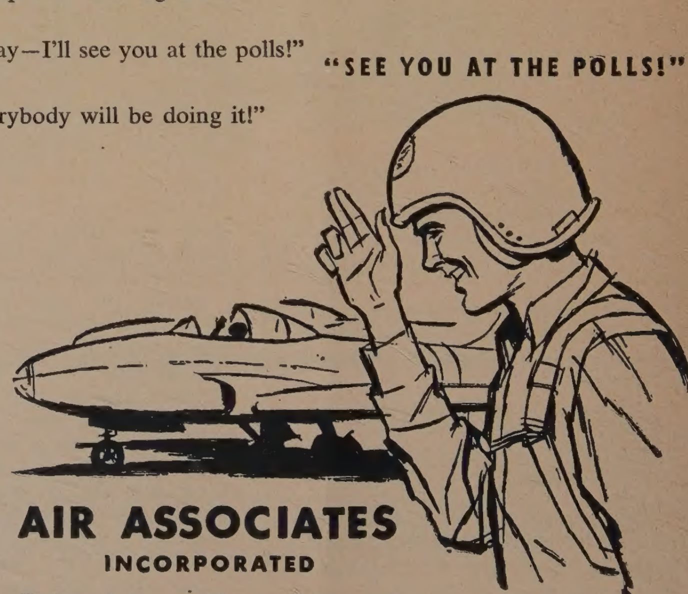
But he said—"I'll settle this the AMERICAN way—I'll see you at the polls!"

And the audience picked up the chant.

Now everybody's saying it—and on Nov. 4 everybody will be doing it!"

"SEE YOU AT THE POLLS!"

"SEE YOU AT THE POLLS!"



AIR ASSOCIATES
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Teterboro, New Jersey

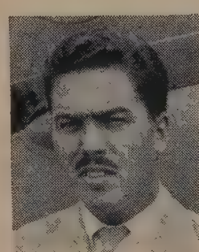
25 YEARS SERVING THE NATION IN AVIATION

in this issue...

Edward A. Driessen whose paper, "The Impact of Turbines on Airlines," was first presented at the SAE National Aeronautic Meeting at the Hotel Statler in New York City, is Director of Research for KLM Royal Dutch Airlines. A graduate of the first Aeronautical University in Germany, Mr. Driessen assisted in the design of the FK 31 fighter and the FK 33, world's first three-engined transport, built in 1924-25 by the National Aircraft Industry of Frits Koolhoven. He joined KLM in 1926 and at the end of World War II he became KLM's Director of Research and Development Department at Schiphol Airport, Amsterdam. An advocate of the flying wing concept, Mr. Driessen submitted a tailless design in a contest for a plane which would fly from Amsterdam to Djakarta in the Dutch East Indies (9200 miles) non-stop with adequate reserve. His design was awarded first prize. But Director of Research Driessen's talents are not confined to matters aeronautical. A current hobby is the aerodynamic improvement of the famous Dutch windmills, which he wants to use for generating electricity. Preliminary testing of windmills for this purpose is presently being conducted.

▶ Reports from France indicate the DC-3 is getting a new lease on short-haul life through the development of a miniature turbojet unit, the Turbomeca *Palas*. Installed on the belly of the '3, this jet unit provides stand-by power for take-off and climb assistance, thereby enabling the DC-3 to meet ICAO recommendations and still carry economical payloads. Our aeronautical correspondent in England, William Green, investigated the operation of the '3 equipped with the jet boost unit, and reports his findings in the article, "DC-3 with Jet Boost." Tests indicate the *Palas* burns 3.2 U. S. gallons of fuel per take-off and causes a slight increase in the fuel consumption of the piston engines because of the drag of the pod. The addition of the *Palas*, however, permitted an increase of five passengers per flight . . . and would, thereby, produce an increase in financial returns. Other tests are now being run using larger and more powerful Turbomeca *Marboré* II's (over 800 lbs. thrust each) on larger aircraft.

▶ "Flight System for ILS" details the linkage between aircraft and navigation facilities. Devoted in the main to an explanation of the operating efficiency gained by use of the semi-automatic coupler, this article describes the various types of couplers and tells the flight operation story of the Collins Integrated Flight System. Its author, Harvey Senior, has been a technical writer on aircraft accessory equipment for many years. He is currently setting up inspection procedures on radio, search radar and electronic equipments.



Bill Abram, executive pilot and author of the article, "Executive Plane Adds Profit," has been active in commercial aviation for seven years. Before joining the ranks of the corporate pilots, Bill owned and operated his own flying service; later spent time being a chief pilot for somebody else's flying service, towing banners, dusting crops, flying charter trips and instructing. He holds a commercial, single and multi-engine land, license; has an instrument ticket and a flight instructor's rating, and a ground instructor, CAR and engines, rating. The last time Bill totaled his time it was over 3100 hours.

▶ Next Issue: The December Flight Operations Round Table will be on the subject of "Cockpit Simplification and Standardization." Participants include representatives of the Air Force, Navy, commercial airlines and also key members of the SAE-7 committee. The Executive Pilot's Report for December features the de Havilland *Dove*.

executive pilot's report

Aero Commander

by Herb Fisher

Chief, Aviation Development,
Port of N.Y. Authority

One of the major problems confronting corporate aircraft owners, who today represent the fastest growing segment of civil aviation, is the lack of airplanes designed specifically to meet their requirements. The corporate fleet now flying the nation's skyways is a conglomerate group of aircraft designed primarily for other purposes.

I was keenly aware of that situation as I stepped into the Aero *Commander* at Washington National Airport several weeks ago to begin an evaluation of this new twin-engine executive aircraft. I had read its glowing advance notices, but I knew that few airplanes ever quite measure up to all printed claims. I adopted a show-me attitude and backed it up with a determination to find out for myself. I did—and here is a somewhat detailed summary of my findings:

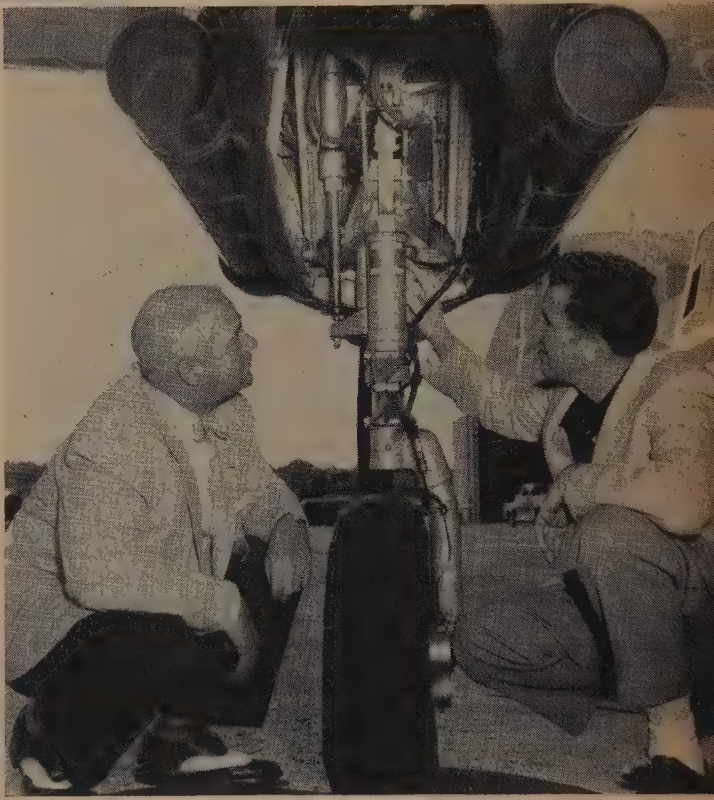
The general aerodynamic performance of the Aero *Commander* is superb. Its stall characteristics in all configurations, both power-on and power-off, are excellent—superior, in fact, to any other comparable twin-engine aircraft I have flown. Its climb-out performance, with full rated power or on one engine, sets a new high standard of excellence in its field. Its single-engine performance at maximum gross weight has probably never been duplicated.

The Aero *Commander* is the business man's airplane. High performance, speed, safety, comfort and utility have been built into this easy-to-fly aircraft, making it an efficient tool of the complete business organization. It bridges the gap between

HIGH-WING *configuration of five/six place Commander offers many advantages, among them excellent visibility. Engines are geared six-cylinder Lycomings (260 T/O hp each); the propellers are constant-speed, full-feathering Hartzells*

VISIBILITY *of Commander is demonstrated in this photo showing Herb at controls of tricycle-geared executive plane. With him is Bob Morris*

CHECK PILOT *Herb Fisher, with Carl Wooten (right), looks over Commander's BT-13 type main gear. Note Lycoming's exhaust augmentor tubes*



the single-engine lightplane, which is inadequate in speed and load-carrying ability for many corporate users, and the large twin-engine transport, which is beyond the reach or needs of many of the same operators.

On the flight from Washington to Teterboro, N. J., I was an observer. My hosts were Carl Wooten, sales manager, and E. R. (Bob) Morris, flight test pilot, of Aero Design and Engineering Company, who had flown the plane up from Bethany, Okla., for a demonstration tour of the East.

Flight Test

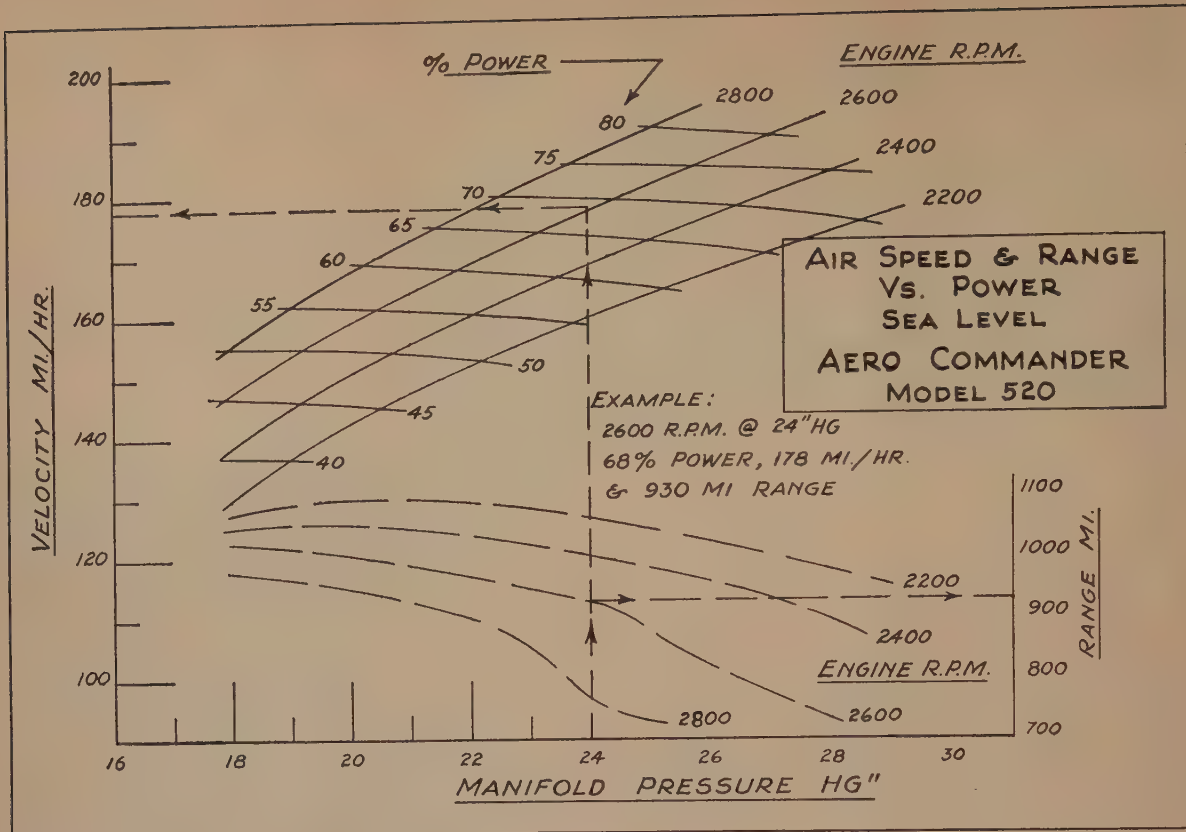
I took over the controls at Teterboro, with Morris, former Chicago & Southern Air Lines captain, beside me and Franklin D. (Jimmy) Walker, vice president of Jefferson Lyon & Co. of Newark and former aviation editor, and Bill Mechnik, North Jersey photographer, as observers.

After a thorough around-the-clock ground inspection of the Aero *Commander*, we stepped into the cabin, ran down the pre-starting check list and were soon rolling down the taxi strip. The plane pivoted 360° beautifully, swinging against an idling inside engine and coming completely around in a 30-foot circle. The two Lycoming engines responded beautifully during the pre-take-off engine check and we were soon cleared for take off.

From the time we started our take-off roll until we became airborne, I knew I was handling a high-performance airplane. Following instructions from Pilot Morris, I proceeded down the runway and advanced both throttles to take-off power (full throttle and 3400 rpm). Due to habit, I glanced at manifold pressure and rpm and they showed me that everything was normal and that the engines were developing full power.

It seemed to me that rudder effectiveness became noticeable long before we hit 50 mph. At 60 mph or slightly beyond, I came back slightly on the wheel, raising the nose, and the Aero *Commander* began to fly off. As we reached safe single-engine speed of 90 mph, I cut rpm to 3,000. Because of the plane's high rate of acceleration and its climb characteristics, I found it unnecessary to push the nose down immediately after take-off.

With rated power at sea level and full gross load, the *Commander* has an initial climb out



of 1700 fpm, and a rate of climb on one engine at normal rated power of 400 fpm.

We climbed to 6,000 feet and cruised to a point well outside the Teterboro traffic pattern before putting the *Commander* through its paces.

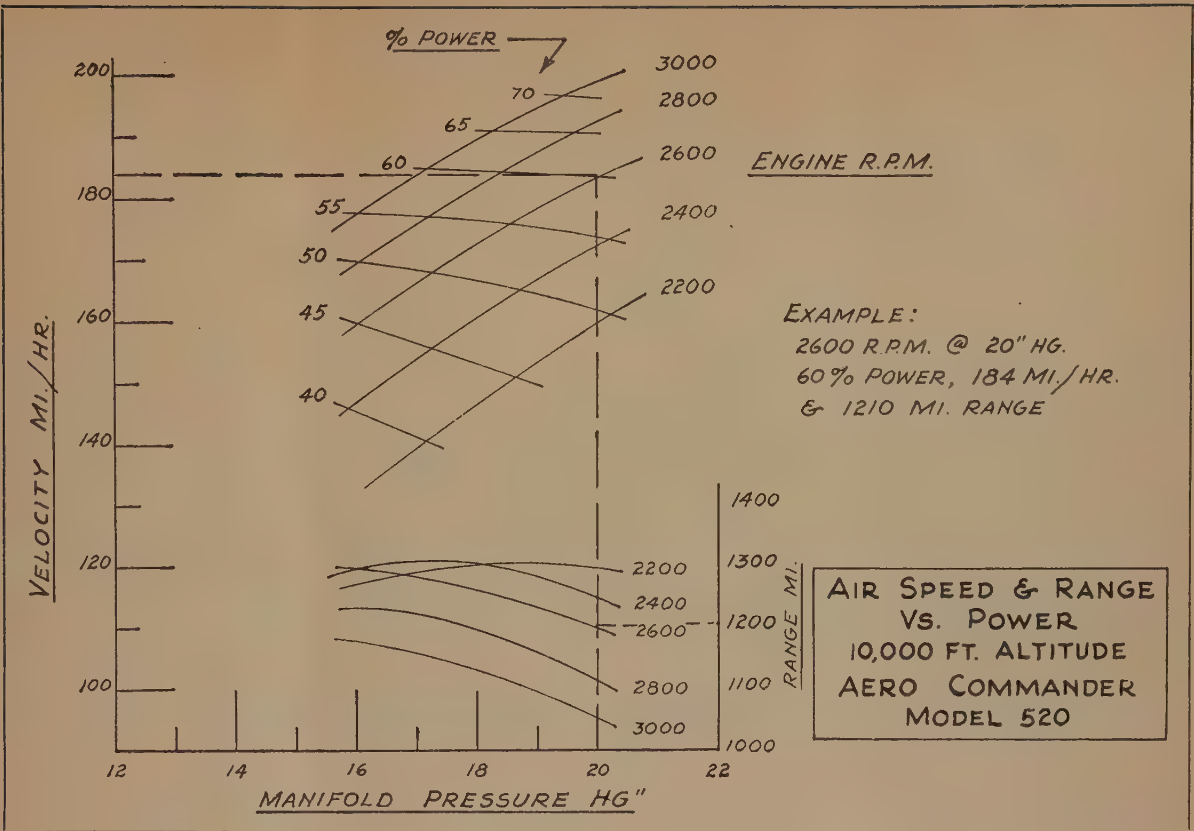
I made an exhaustive check of the *Commander's* stall characteristics and can report that they can be described in superlatives. In both power-on and power-off stalls, the airplane gives ample warning of the approaching stall, a warning easily recognized by any pilot. In fact, this airplane is almost a stall warning indicator in itself.

In a power-on stall, with gear and flaps down, and the airplane at a terrific angle of attack, the *Commander* provides a good warning just before stalling at the remarkably low airspeed of 40 mph. With a touch of coordinated aileron and rudder, the nose will fall straight through and, by a slight relaxation of back pressure, the stall recovery is made. The airplane is flying again by the time the nose reaches the horizon. Lateral and directional control is never lost and, after the nose pitches forward toward level flight, the elevators can be held against the nose-up stop and the airplane controlled by ailerons or rudder for any period of time with the ship executing a controlled rate of settle. Stall speeds, based on the engine manufacturer's power curves, are: full flaps, power off—60 mph; flaps and gear retracted—67 mph; full flaps, power on—40 mph.

I was surprised and pleased to discover that the *Commander* is equipped with electric trim tabs, and I believe it is the only small transport-type aircraft to incorporate them. They are controlled by two small toggle switches on the quadrant. The speed or sensitivity of the trim tab motor actuator is controlled by the incorporation of a rheostat just to the right of the trim tab switches. When turned to the high position, the switch makes it possible for the pilot to make quick trim tab adjustments. The low position enables him to make very fine adjustments at cruising speed. There are trim tab indicators on the instrument panel to show the pilot positive trim tab position.

One-Engine Out

We shot several landings and take-offs at Wright-Caldwell Airport and it was during those tests that I was introduced to an unusual method of handling a plane during a take-off engine failure. In all my flying experience, it has been my practice to obtain and maintain maximum forward speed whenever an engine failed on take-off. Morris said, "Not in this airplane—just try it and see."



Before one of our Wright-Caldwell take-offs, I planned to idle on one engine after take-off and not feather the propeller. Well, we took off and before I realized it we had an indicated 105 mph. I pulled the right engine throttle back and held the nose level for more forward speed. Morris yelled pull nose up, reduce speed to 90 mph. Although every instinct told me to crowd it on for maximum speed, we climbed steadily at 90 mph, with a whistle of surprise from the observers in the back seat.

The best rate-of-climb speed for the *Commander* with one engine out is 95 mph. It can be flown safely at 80 mph on one engine and turns can be made into and against the bad engine at that speed, but any increase above that mark naturally improves handling characteristics.

Landing Procedure

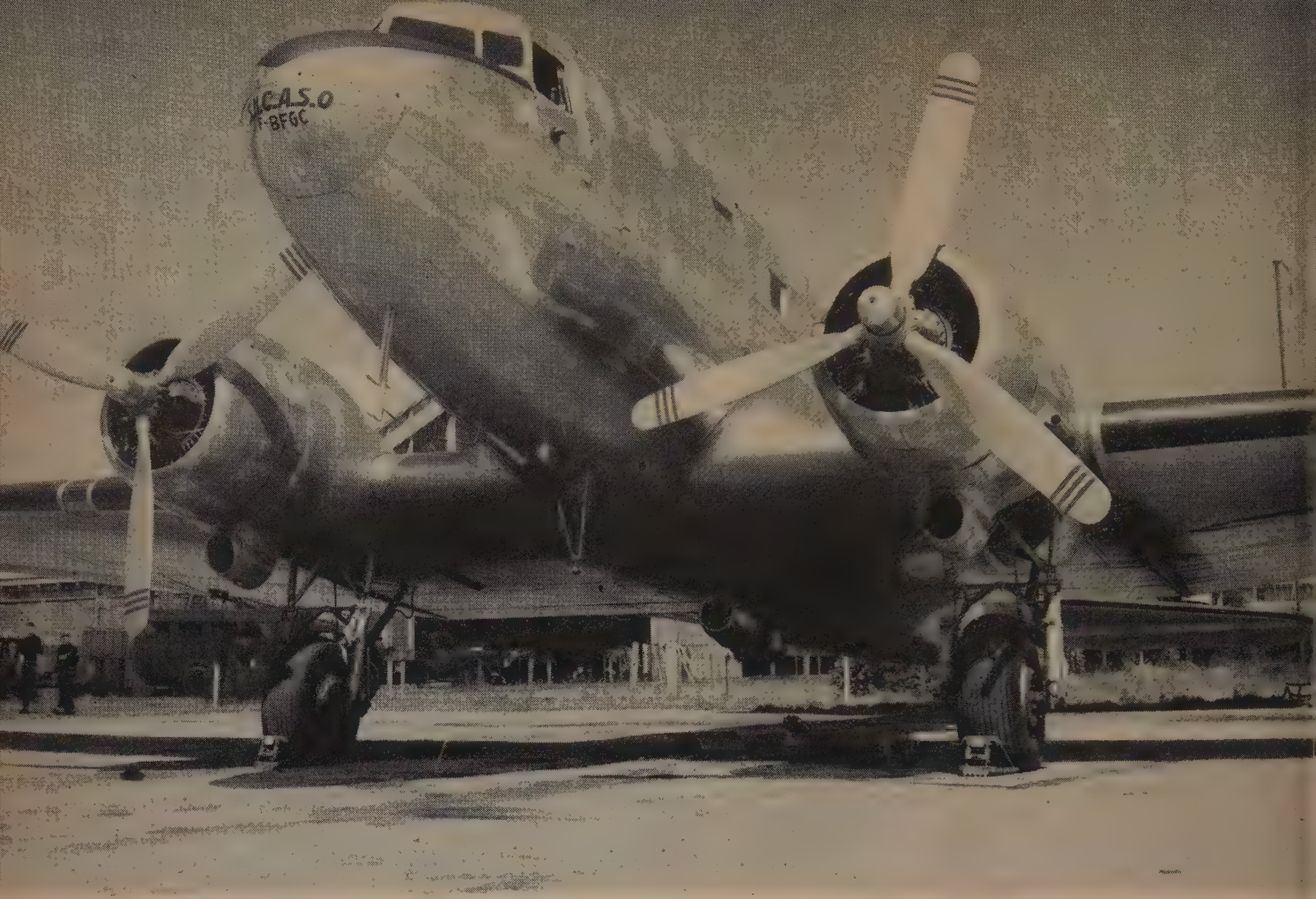
With its two engines and trim lines, the *Commander* looks like a "hot" airplane but it can be maneuvered as easily as a smaller, single-engine aircraft. Approaches and landings are made normally with the *Commander*, although its high performance makes it reluctant to slow down in a short distance unless power is reduced appreciably. This should be kept in mind when approaching the downwind and base legs.

After shooting several landings I found the following landing procedure the best to follow in the *Commander:*

Slow to 120 mph or less when approaching the end of the runway on the downwind leg. When even with the end of the runway, turn on the boost pump and extend landing gear and then start the base leg. A good, safe speed in the pattern, with flaps up, is 100 mph. Slow to 80 mph and trim on the final approach. Advance propeller controls full forward when just short of the landing strip. Landing is in the conventional manner, in a slightly nose-high attitude. When main wheels contact, hold the wheel back slightly and ease the nose wheel to the runway. Apply brakes after the nose wheel touches. It's that simple.

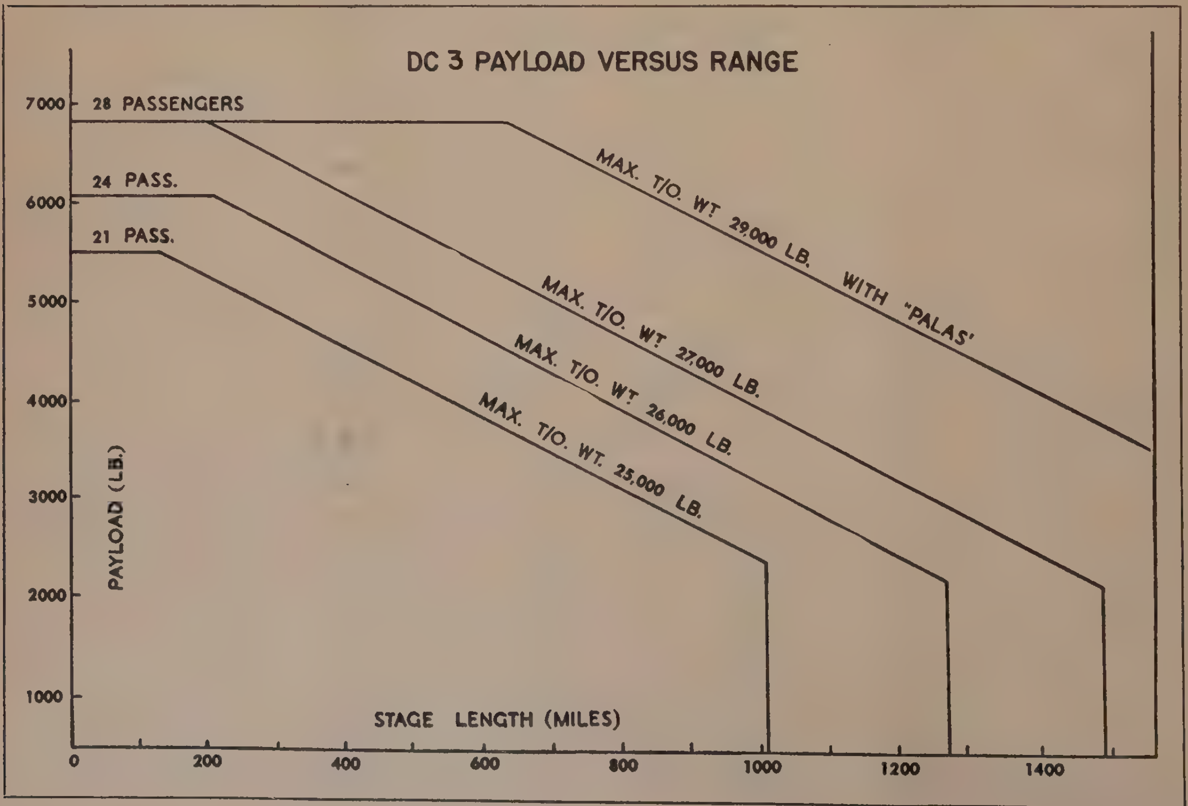
The aerodynamic qualities of the *Commander* were amazing, especially after what the airplane showed me during one final approach at Wright-Caldwell. On that final approach, I dropped the flaps and landing gear and was instructed to hold the control wheel full aft. All we did was float all the way in. Stalling with the wheel back on final approach was a new experience for me, since it is normal to do the opposite in such cases.

The crosswind performance of the *Commander* also is excellent. There (*Continued on page 38*)



DC-3 TRANSPORT *with Turbomeca Palas jet unit as booster is currently undergoing further testing in France. Purpose of jet boost is to provide stand-by power for take-off and climb assistance to enable DC-3 to meet ICAO requirements*

PAYLOAD VS. RANGE *graph shows increase in payload, stage length for DC-3 equipped with Palas and carrying 28 passengers, 200 lbs. baggage, 1,320 lbs. freight; cruising speed: 178 mph (with 10-mph headwind); and fuel reserve: 750 lbs.*



DC-3 with jet boost

Addition of Palas unit enables DC-3 to meet ICAO requirements and still carry economical payload

by William Green
British Correspondent

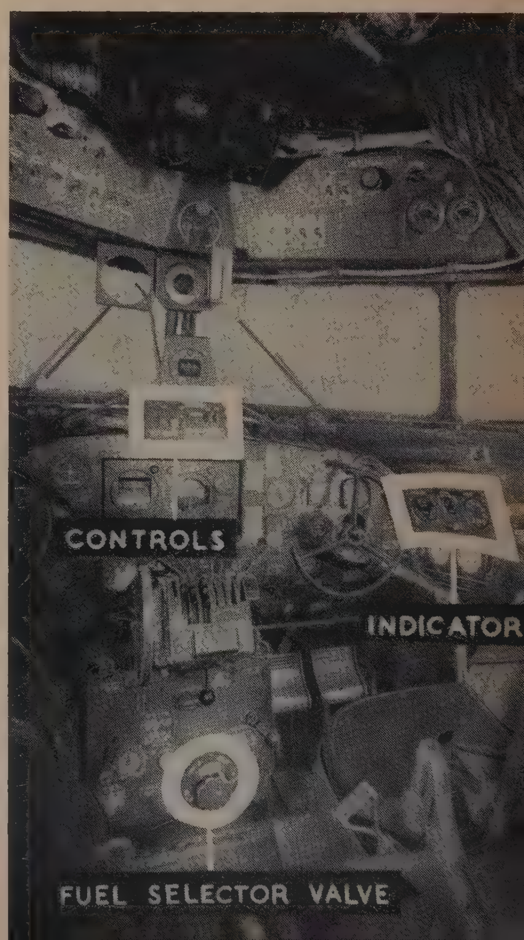
For the many operators throughout the world who are casting around to find an inexpensive means of implementing ICAO requirements with their DC-3's (or converted C-47's) which can no longer meet the recommendations except with a much-reduced and therefore uneconomical payload, a new and intriguing possibility has entered the picture in the form of booster turbine units to provide stand-by power for take-off and climb assistance.

The ICAO recommendations resulted in much wailing and gnashing of teeth, for the "Old Lady" of the airways still tops the popularity poll for use as a medium-sized corporate or executive transport and short-haul airline plane, and few of its operators, with the exception of major airlines and large corporations, are able to afford new airplanes; some having paid their way *only* because their ex-C-47 airplanes were brought in and converted at prices quite unrelated to their value when new. Additionally, few new aircraft are likely to offer the same economy of operation, and particularly maintenance, as Douglas's venerable work-horse.

Surprisingly, it is in France that the most practical approach to the DC-3 rejuvenation problem has been made; one that is likely to appeal to the executive operator and short-haul airline alike, namely, the addition of one or two miniature turbojets under the belly or wings of the DC-3, the installation of which can be easily effected during normal overhauls. But the basic idea, although originally conceived with the DC-3 in mind, is equally adaptable to other twin-engined airplanes—a Curtiss C-46 owned by the Brazilian operator VARIG is presently being fitted with two such booster units—permitting, under Tropical Maximum conditions, the use of better payloads and ranges than those possible with unassisted aircraft in normal temperate atmosphere conditions.

The idea for a jet boost was first proposed more than a year ago by the *Société Nationale de* (*Continued on page* 60)

COCKPIT *controls (center panel), indicators (side panel) are electrically operated. Fuel selector valve (center pedestal) enables pilot to feed jet from any tank*



by Edward A. Driessen
Director of Research K.L.M.

THE IMPACT OF TURBINES ON AIRLINES

Jet is next in air-transport picture, but some difficulties still remain to be solved

There are no doubts about the general future aspects of turbine engines vs. piston engines; the general feeling is that turbine engines will be the next big step forward in the development of civil air transports. The piston engine will not be eliminated from the transport picture in the near future; it may still be used to power short-distance feederline aircraft. But the civil transport planes on our trunk lines will be powered by turbine engines within a decade.

We are now about to open the door to a new era, the era of the turbine. And we will have to adapt our way of thinking to the new powerplant which, though still in its infancy, is promising more speed, more power and more passenger appeal than we have ever known.

The airlines, however, should pay attention not only to the possibilities but also to the difficulties of the turbine-powered airplane. It is generally more critical in operation than its piston-engined forebear, both technically and operationally.

Turbojets or Turboprops

In order to compare jet engines (producing thrust) with turboprops and piston engines (producing horsepower) simplifications are inevitable, and thus any method of comparison will give a trend rather than precise figures.

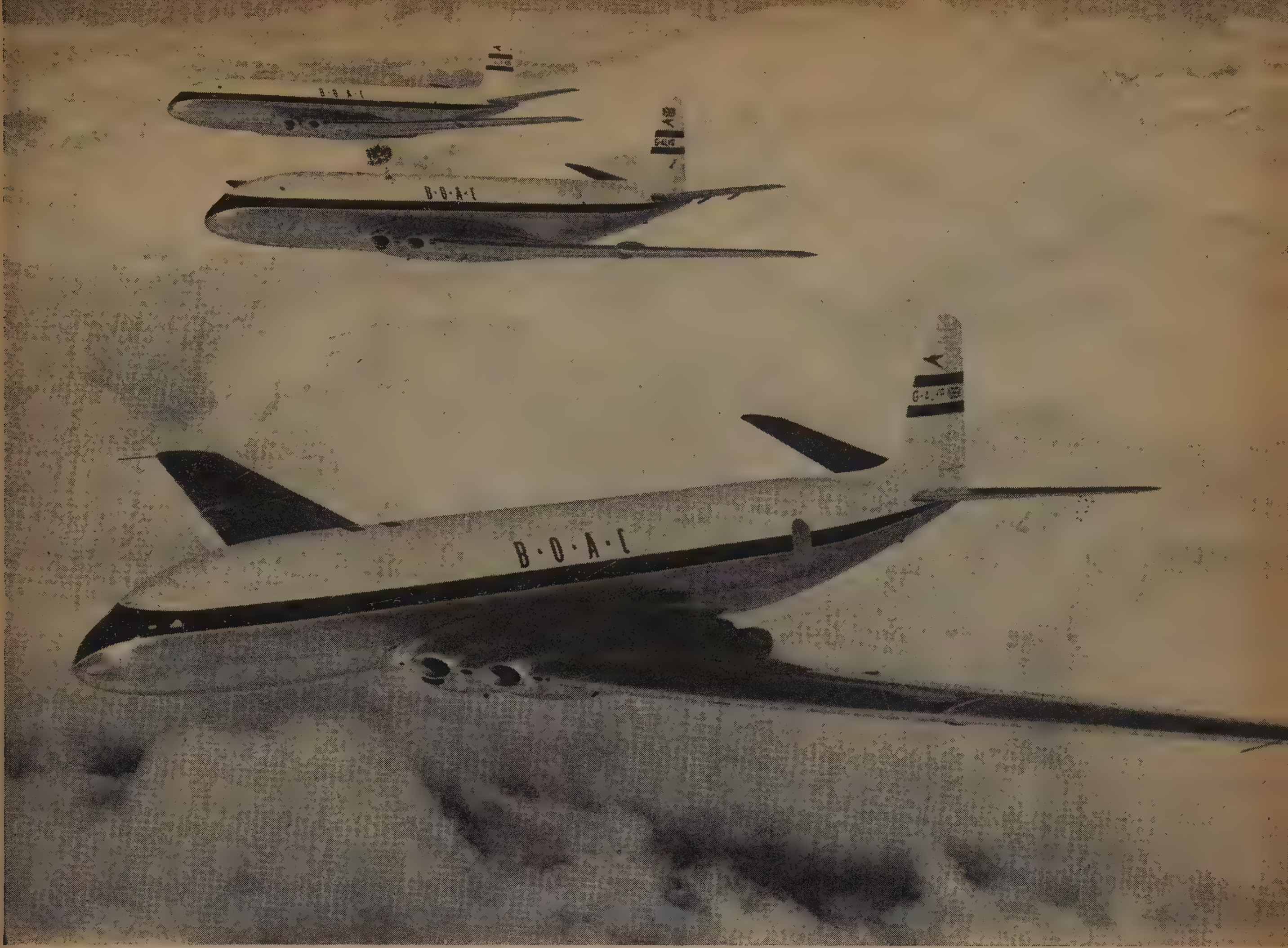
Our comparison of the turboprop and the turbojet engine is based on the following thesis: that the most suitable engine type for certain stage lengths and certain operating conditions is determined by the minimum total weight of 1) the complete power group; 2) trip fuel; and 3) reserves.

The turbojet engine is the powerplant which promises the biggest gain in the commodity which the airlines are selling—speed, and this speed coincides with a maximum of comfort due to the following factors: 1) vibration will be almost eliminated; 2) high block speeds and, consequently, journeys of short duration; 3) lower noise level; and 4) high-altitude flight will reduce gust and bad weather factors.

Technically, jets and turboprops are nearly identical, with the added complication of propellers and their associated difficulties on the turboprop. Therefore, provided we can operate turbojet-powered aircraft safely and economically, we should choose turbojets for airline operations.

The high-speed economy of turboprops is governed by the efficiency of the propeller. If propeller efficiency could be improved, the turboprop would still be able to compete with jets due to its inherent advantages of better take-off characteristics; ability to fly slower and lower without excessive increase in fuel consumption (holding procedures!); better acceleration characteristics (overshoots); and the possibilities of using reverse thrust for landings on slippery runways.

Many problems are still connected with the propeller. A 10,000-lb. supersonic propeller (comparable with jet engines of the near future) gives a sound level of 150 db (well above pain level!) at 30 ft.; vibration and flutter problems are acute. Very wide blade chords and high torsional stiffness are necessary. Take-off performance of these props is also poor, in fact, the characteristics of an aircraft with supersonic props may be very similar to



DE HAVILLAND COMET, *jet-powered 36-passenger air transport, has been placed in operation by British Overseas Airways Corporation on its London to Johannesburg, S. A. run*

those of a jet aircraft. If this tendency continues, the future of supersonic props seems very doubtful.

Consequently, in the future the jet airliner is the best type of airplane for luxury (1st class) transport, while the turboprop-powered aircraft, due to its combination of high power and good take-off characteristics, may play an important role for coach (2nd class) transport and freighter. The former will carry a relatively low number of passengers (40-60) at high speed (500-600 mph), the latter will carry a great number of passengers (80-130) at moderate speeds (300-400 mph).

I propose that we turn the spotlight especially towards the turbojet-powered transport, as the characteristics of the turboprop-powered airplane are usually less revolutionary. If we can operate turbojets, there is no doubt that we can operate turboprops. Consequently, let's review the various aspects of economy, operations, maintenance, etc., for both present-day and future airplanes, starting with the basic propulsion unit: the gas-turbine engine.

Engines

Something which ranks high in airline operation is the engine control system. The control of any engine has to satisfy the following requirements:

1. Simplest possible regulation, preferably by one handle only.

2. The control must be able to select any desired power setting within the operating limits of the engine.

3. The transition from one power setting to another must be prompt, smooth and at the maximum safe rate of change.

With the older types of turbojets, engine control basically consists of metering the fuel supply, thus power is selected by varying one factor. This favors one-handle selection. With newer types of turbojets (incorporating variable area nozzles) and with all types of turboprop (with constant-speed propeller), another variable factor is introduced. To maintain one-handle power selection it is necessary

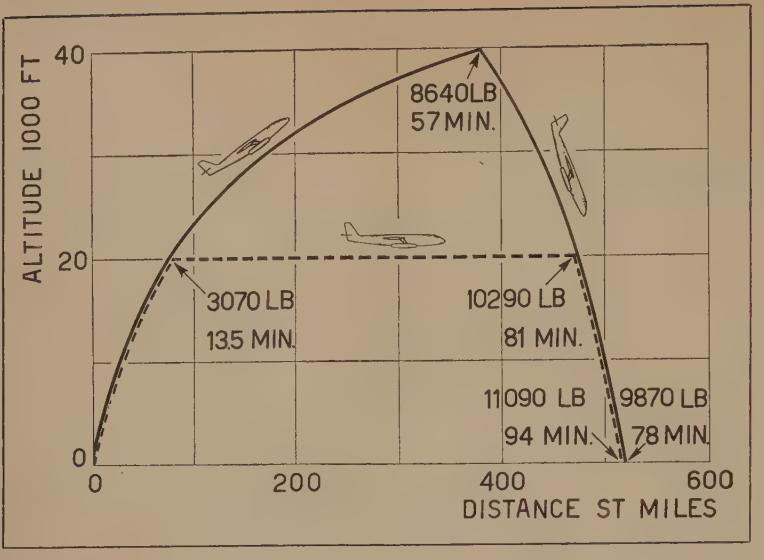


FIG. 1—*Chart shows fuel consumption and flight time for an airplane with turbojets. Note climb, then jet's quick descent*

to coordinate both variable factors automatically, either by mechanical linkage (Rolls Royce *Dart*) or by electronic controls (Allison T-38). The former is very straight forward and reliable in operation, but simplifications in the coordinating functions are required for this type of linkage; consequently, the power settings will not always be at the optimum value. The latter controls are more complicated and subject to failure, but enable the powerplant to operate at its peak of efficiency at all power settings. The coordination of engine and propeller is a very complicated matter and many prototype turboprops have teething troubles with their power-control systems.

Even with present-day simple jet engines, it is still impossible to maintain a fixed engine rpm at a pre-selected control-handle position under all flight conditions. During transition from one power setting to another, the balance of the engine flow control may be seriously disturbed, and appreciable fluctuation of fuel flow may result. Consequently, the temperature limits may be exceeded during transition, and surge or blowout may result.

As even a short period of operation at temperatures above the safe limit may seriously reduce the life of turbine buckets, a reliable automatic temperature limit control is urgently needed. The pilot often is too preoccupied to react sufficiently fast when tailpipe temperatures rise quickly. At this time, however, automatic overriding controls have not yet passed the laboratory stage. The development of a reliable control system for gas turbines presents a problem of considerable magnitude, because requirements are far ahead of solutions.

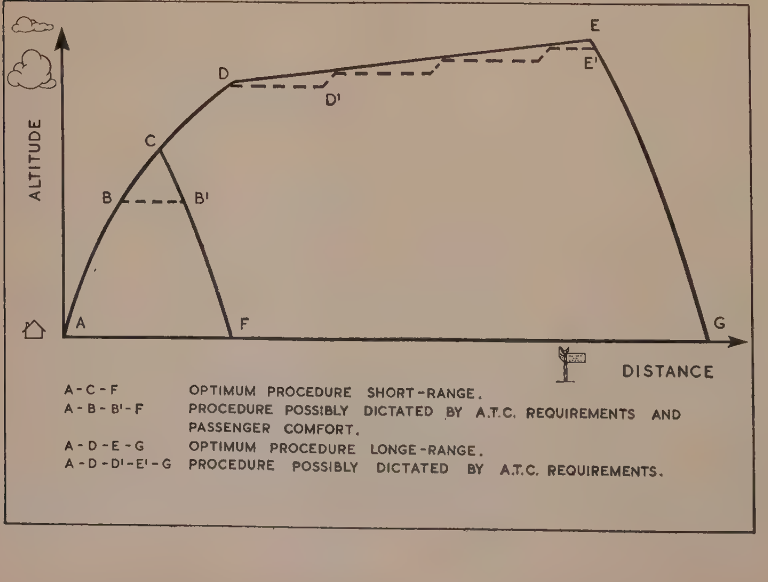


FIG. 2—*Chart shows flight procedure for climb, cruise of jet transport. ATC may require a level cruise with occasional climbs*

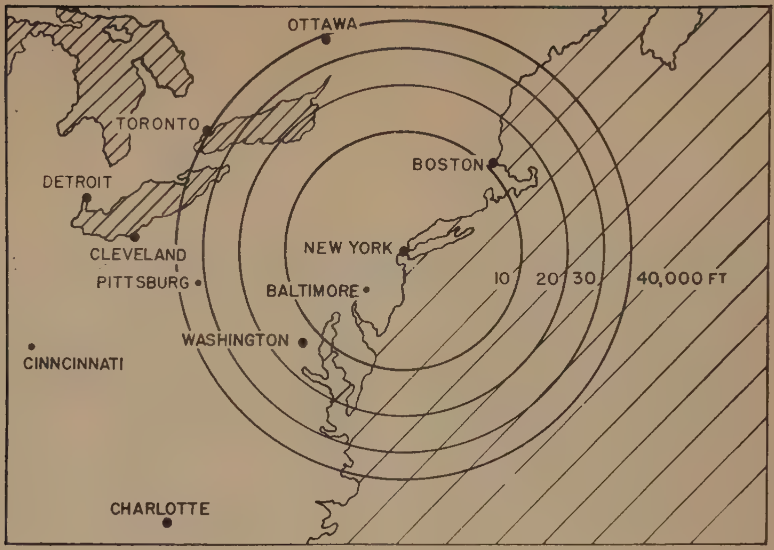


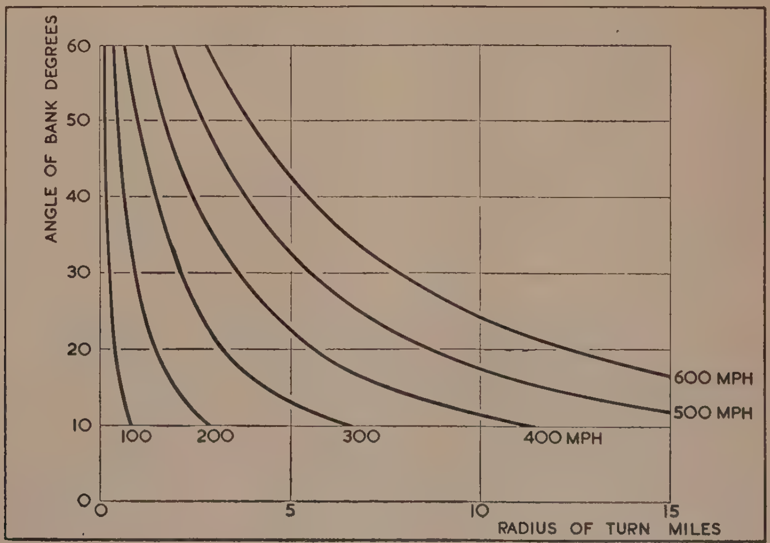
FIG. 3—*Map shows radii of VHF transmission, reception of aircraft flying over New York at altitude. Note increase in range*

Personally, I would like to see turbines engines being controlled primarily by turbine temperature: the pilot would select a certain turbine temperature and this would then be maintained automatically. To prevent overspeeding during a cold-day take-off, an automatic overspeed-preventor must be provided. This method would cut temperature variation of the turbine to a minimum and, thus, might reduce maintenance.

Another important aspect of gas-turbine operation is the required accuracy in power settings by the airplane crew. Fuel consumptions change *if* the engine rpm differs from the pre-selected value for cruising conditions. This may occur through lack of vigilance from the crew, for instance. The turboprop appears to be somewhat more sensitive than the turbojet in this respect.

Acceleration characteristics of the jet engine are somewhat sluggish compared with piston engines, which is mainly due to the low acceleration at speeds just above idling speed (25% of maximum rpm). This is definitely unfavorable for balked-landing procedures. Therefore, a relatively high engine rpm is recommended for approach; this procedure, however, gives very long landing runway lengths due to high approach thrust. Much better landing characteristics may be obtained by using a variable-area jet nozzle. By maintaining a relatively high rpm with wide open nozzle, and shutting the nozzle when an overshoot is initiated, approach thrust is minimized and the acceleration-time to maximum thrust decreases appreciably. The turboprop aircraft accelerates faster than the turbojet airplane due to (*Continued on page 44*)

FIG. 4—*Increase in cruising speed means an increase in turning radius. Collision-warning systems, therefore, are important to jets*



Business Plane Adds Profit

by Bill Abram

Pilot, Machinery Co.

Machinery Company executives credit airplane for doubling its business in year

PILOT ABRAM *saves money for his company by washing and waxing Cessna 195 himself. He estimates saving to be $125 per month*

This is the story of two businessmen, a Cessna 195, and a fast-moving organization. Last year Cleon Miner and Bill Geyer were faced with a decision. Their Machinery Company in Mishawaka, Indiana, was growing by leaps and bounds (this company specializes in buying and selling heavy industrial machines and even whole industries). Their job was to jump from one state to another, filling orders, buying, selling and trading. It called for fast moving and instant decisions. Consequently, these two men were having to drive 12 and 13 hundred miles per week. The airlines either did not serve some of the cities on their schedule or, if they did, departure times didn't coincide. Trains were out of the question.

Finally, the day of decision came. Through sheer exhaustion, the two men one day actually drove right past their establishment, and didn't realize it until they were practically on their way out of town again.

The men had a quick coffee at a drive-in and made their decision—"We're going to buy an airplane and stop this day and night driving."

Business friends were disposing of a Cessna 195, and buying a larger twin-engine ship. After a short sales talk, Cleon Miner and Bill Geyer turned a corner in their business careers and embarked upon an experiment which was destined to help them grow even faster. They became the proud owners of a Cessna 195, complete with ADF, omni, marker beacon receiver, low-frequency stand-by transmitter and receiver, and full instrument panel (always hangared, never cracked, etc.).

Today, one year later, the 195 is an indispensable component of an expanding organization.

Being the pilot of this company plane, I've had ample time to see how the company has utilized its Cessna 195. Through the medium of the air, Machinery Company has *doubled* its business. I've seen how the airplane has had the effect of a greater sales force without actually increasing the number of salesmen on the payroll. When you can make your own schedule and alter it to coincide with a customer's plans, you have a decided ad-

EXECUTIVES *Bill Geyer (left) and Cleon Miner flew 822 hours in business Cessna during first year of operation. Pilot Bill Abram estimates cost per-seat-mile to be a low .034¢*

vantage over competition that must rely on strict airline schedules or the automobile.

A pessimistic individual remarked the other day, "Don't you spend most of your time on the ground waiting for the weather to break? Pilots look like a lazy lot to me. They'd probably prefer hanging over a cup of coffee, talking about flying rather than actually doing it."

He's right on one point: when the weather gets bad, I get awfully lazy. So do my bosses. Consequently, we have some very good friends in the insurance business. I would rather sit on the ground in Podunk than spend terrifying minutes in the air finding out the forecaster was right about that icing in the clouds.

We estimate we make at least 85 percent of our schedule. Not a bad percentage considering the fact that our operation is confined mostly to the Great Lakes region and the eastern portion of the United States. A typical flight will take us to Indianapolis, St. Louis, South Bend, and Detroit. The next day, perhaps, our itinerary will include Battle Creek, Chicago, Peoria, and back to South Bend to spend some time with the wife and kids. Under average conditions, New York City is a mere 4:30 flying hours from South Bend, with the bosses arriving fresh and rested.

Newark Airport as destination, we can depart South Bend at about 9 in the morning, and six hours later be in our rooms at the Hotel Statler in downtown New York. Surface transportation from Newark to Manhattan has always proved very convenient. The six hours from South Bend to New York includes a gas and lunch stop at Youngstown.

About 5 o'clock one evening recently I was busy putting the airplane to bed for the night when a phone call came through from Mr. Geyer.

"Check the weather, Bill," he said.

"Sure," I replied. "Where to?"

"Fort Worth."

"For tomorrow morning, Mr. Geyer?"

"No, now. Tonight."

The next morning at 0800, Meacham Field at Fort Worth was under our (*Continued on page 57*)

Flight System for ILS

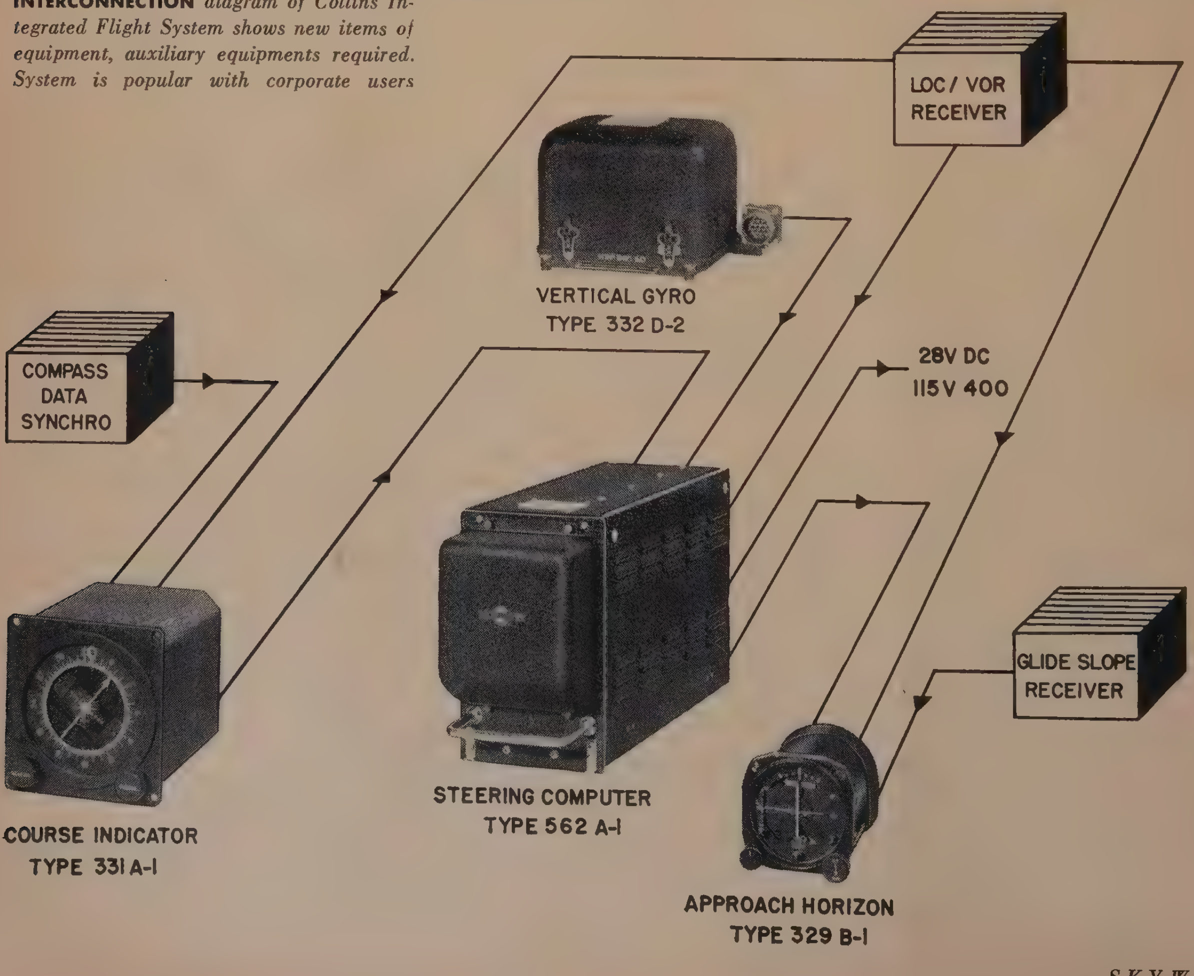
by Harvey A. Sencot

Details of components and the use of the semi-automatic approach coupler

Airplane navigation along airways and on approach to the airport runway in times of reduced visibility is based almost entirely upon use of the radio ranges and the instrument landing system (ILS). In order to make use of these facilities, means must be provided to link or to "couple" the aircraft to the navigation facility. Accordingly, the equipments carried aboard the airplane to accomplish this result have become known as "couplers." The three general types of couplers in present-day use or under consideration are: manual, semi-automatic, and automatic.

This article will provide a brief section devoted to the necessity for a coupler, a brief description of each of the three types of couplers and a description of the components and method of use of a representative type of semi-automatic coupler. It is felt that the manual system is well known and

INTERCONNECTION *diagram of Collins Integrated Flight System shows new items of equipment, auxiliary equipments required. System is popular with corporate users*



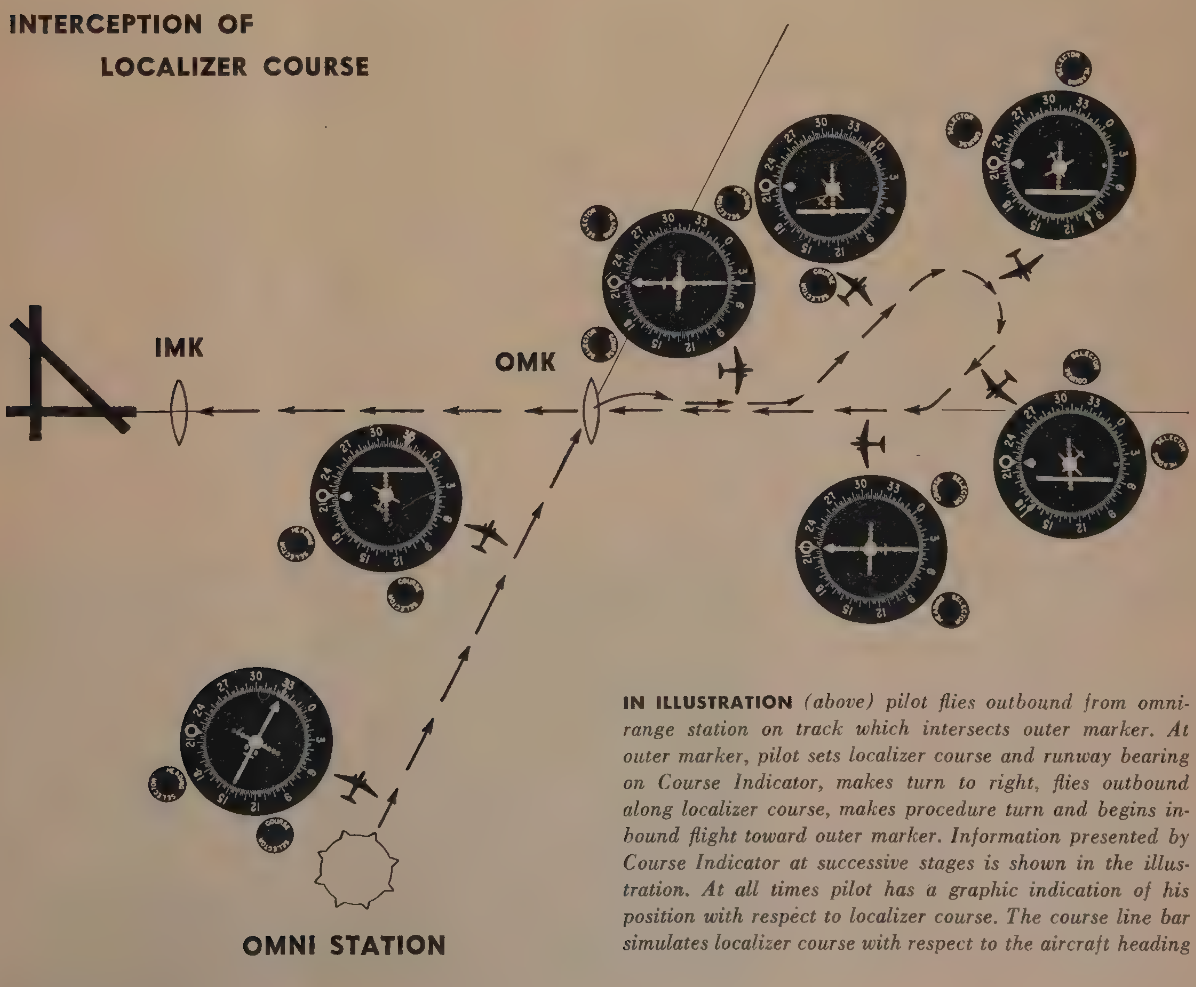
fairly well standardized in regard to the airplane equipments and that the automatic system is, in general, just about reaching the service test phase for commercial use. Therefore, it is hoped that the following material will make apparent many of the advantages in operating efficiency to be gained by use of the semi-automatic coupler.

A pilot making a cross-country flight must have two types of information in order to guide his plane from a point of departure to a point of destination. He must have "attitude" information so that he may be aware of the relation of his plane to a fixed reference such as the earth's surface, and he must have "positional" information so that he may know his geographic location in relation to fixed points on the earth's surface.

Under contact flight conditions, necessary information is obtained almost entirely by visual reference to objects external to the airplane. To illustrate, attitude information is obtained by visual reference to the horizon for pitch and roll and to landmarks for direction. Positional information is obtained by visual reference to landmarks below. An exception to this may be the use of a compass within the airplane for directional reference.

Under instrument flight conditions, however, information must be obtained entirely by reference to objects within the airplane or, more nearly, within the flight compartment. Indications of the various "flight" instruments such as compass, turn-and-bank, airspeed, and other such, are utilized to maintain attitude of the airplane within normal limits. Indications of the various "navigation" equipments such as radio range receivers, marker beacon receivers, and direction finders are utilized to determine airplane position with regard to known ground locations.

Under both contact flight conditions and instrument flight conditions, then, a pilot is actually a servo-mechanism that receives error indications, analyzes relevant factors, and initiates proper control movement for airplane guidance. Instrument flight requires intense concentration on the part of the pilot in order to maintain airplane attitude within desired limits and to be aware of airplane geographic position at all times. The information



IN ILLUSTRATION *(above) pilot flies outbound from omni-range station on track which intersects outer marker. At outer marker, pilot sets localizer course and runway bearing on Course Indicator, makes turn to right, flies outbound along localizer course, makes procedure turn and begins inbound flight toward outer marker. Information presented by Course Indicator at successive stages is shown in the illustration. At all times pilot has a graphic indication of his position with respect to localizer course. The course line bar simulates localizer course with respect to the aircraft heading*

FIG. 1—*Face view of Approach Horizon shows the Pitch Indicator Trim knob (lower left) and the HDG-ILS switch (lower right)*

FIG. 2—*Face view of Course Indicator, (far right) shows compass card with presentation of aircraft heading course displacement*

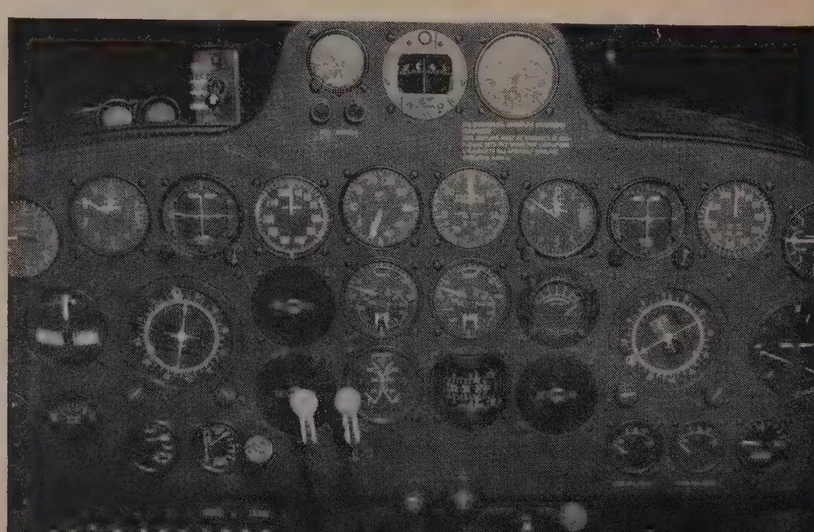
presented by the several attitude instruments must be recorded visually, interpreted, and transposed into requisite control movements when required. A similar process is followed in the case of navigation information except that some of this information is recorded aurally—tower instructions, radio range data, and weather information; while the remainder is recorded visually—direction finder indicator, directional gyro, and compass.

Types of Couplers

Flying on instruments along the airway, from range station to range station, is fairly simple as compared to the exacting procedures required to make an instrument letdown from the airway to the runway of a terminal airport. It was stated in the beginning of this article that airplane navigation along airways and on final approach to the runway in times of reduced visibility is based almost entirely upon use of the radio ranges and the ILS. Material directly following will describe the three general types of "couplers" carried aboard aircraft to link or "couple" the aircraft to the navigation facilities, such as the radio ranges and the ILS.

Manual—consists of omnirange receiver and glide slope receiver with associated antennas, and a two-needle deviation indicator (cross-pointer meter). Deflection of the vertical needle shows airplane geographic position in relation to the glide slope beam center. This setup permits guidance of the airplane to and along the omnirange beam, and permits approach to the runway on ILS facilities, but requires skillful interpretation of meter indication and dexterous application of control movement, particularly when on final approach, in order to prevent instability due to over-controlling. Airplane attitude and heading information must be derived from the several requisite instruments according to instrument flight standard practice.

During final approach to the runway under low visibility conditions, the pilot will be entirely on instruments. As the airplane breaks through the ceiling, it is necessary for the pilot to effect a transition from instrument flight to contact flight. Shortly thereafter, he must decide whether a normal landing is possible or a "go-around" is necessary. A normal landing is effected by visual reference to the runway. A "go-around" (*Continued on page 40*)



FLIGHT SYSTEM *instrument panel for Twin-Beech was set up by Smith-Meeker. Note dual Approach Horizons, Course Indicators*

by Fred Schonenberg
U. S. Aviation Underwriters, Inc.

APPROVED PILOTS

Pilot clause in aviation insurance contract reflects key condition of corporation's air transport operation

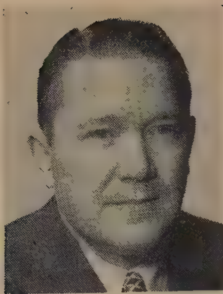
This past summer at a meeting of aviation people, convened to discuss safety measures, a remark was made to the effect that insurance markets, by insisting on certain standards of pilot qualification, were playing an important part in the drive for fewer aviation accidents. As much as this is the opinion of some, there exists others' belief that aviation has been retarded in experience development by the direct and too conservative intervention of underwriters into the matter of who can and who cannot pilot certain aircraft and still have insurance apply. Since almost every aviation insurance policy written today covering an aircraft in flight has a pilot clause as an important condition, it seems that the story of pilot clauses ought to be aired to answer the comments which prevail among pilot and operator groups.

For you who are not familiar with the effect of a pilot clause, the situation is that the insurance policy contains a declaration whereby coverage only applies when the aircraft is being operated "in flight" by certain specified pilots. These pilots may be identified either by name or by qualification as to certificate and experience. In the case of an easy-to fly lightplane, the clause may state—"Pilots holding proper certificates as required by the Civil Aeronautics Authority." If the ship were a fast twin, the field will be narrowed to perhaps twin-engine rated commercial-certificate carrying pilots, each of whom has a minimum of 2,000 hours first-pilot time of which at least 200 hours have been logged in multi-engine aircraft. Should any accident or occurrence take place as a result of operation in flight by lesser qualified pilots, the insurance company is in a position to refuse to pay hull loss or in the case of a liability policy to pay claims or even defend the insured against claims made by injured parties.

As a matter of history, pilot clauses are the result of 30 years of trading by aviation and insurance companies. The former seeks the most coverage it can obtain for the least premium; the latter seeks to sell as much insurance as it can at rates which will insure a profit for management but yet be acceptable to buyers. To make the happy trade, certain compromise is necessary. On the matter of pilot clauses the compromise has been and will continue to be an unsettled item.

There is little record of aviation insurance prior to 1920. Insurance, although daring at other times, was tightly conservative up until the '20's insofar as aviation was concerned. As there are leaders in all fields so there were leaders then who sought to bridge the gap between aviation and insurance so that both might benefit. On one side were aviation pioneers who hoped someday to make aviation "big business." Without insurance they knew this to be impossible. On the other side were insurance men who, in investigating all possible markets for their product, learned enough about aviation and believed in its future enough to want to lean out. The island where the sides met was supported on the shoulders of *pilots*.

You must go back to the '20's to appreciate this. When there, you would see the heart and core of growing aviation to be men who, through some faculty of mind and body, could pick a possible airplane from many, many amateurish rigs and then fly it despite its faults. The personal scrapbooks of these "old-timers" is an amazing commentary upon their particular talents. Is it any wonder that aviation, recognizing this key (*Continued on page 56*)



Hall L. Hibbard

R. T. Holland

Robt. E. Hage

J. H. Aldrich

W. A. del Valle

C. R. Davenport

R. P. Kroon

K. C. Gordon

LESLIE E. NEVILLE (left), moderator of this Round Table, is Director of the Armed Services Technical Information Agency. He is a former magazine editor; has authored several aviation books.

HALL L. HIBBARD, Vice President and Chief Engineer of Lockheed Aircraft, began his aviation career in 1928 with Stearman Aircraft Corp. He joined Lockheed in 1932; was named vice president and chief engineer in '33. Under his engineering leadership, Lockheed transports and jets have established world standards.

ROBERT T. HOLLAND is Product Planning Engineer for Transport Systems in Contracts Operation, Aircraft Gas Turbine Div., General Electric Co. A graduate of Northeastern University, he joined General Electric in 1941. He is a member of AIA, Engine Technical Committee, and is affiliated with IAS.

ROBERT E. HAGE is Project Engineer for both military and commercial aircraft at Boeing Airplane Company. He was awarded a BS degree in Aeronautical Engineering at University of Washington, and an MS degree by MIT. He presented the first series of lectures for Baetjer Memorial Lectures, Princeton.

JOHN H. ALDRICH, Chief Aviation Forecaster, Weather Bureau Airport Station at Los Angeles, is a professional member of American Meteorological Society, and a member of Southern California Soaring Association. In his present WB assignment he furnishes aviation weather forecasts for southwestern U.S.

WILLIAM A. DEL VALLE, Pan American Airways' Resident Engineer at Douglas Aircraft Co., is a graduate of University of Michigan. He joined aviation circles in 1928 with Stout Airplane Division, Dearborn, Mich. He joined PAA in 1934 and has since served as Resident Engineer at Lockheed, Boeing, etc.

C. R. DAVENPORT, Eastern Air Lines Engineering Representative on the Constellation project at Lockheed, is a native of New Jersey. He studied aeronautical engineering, later learned to fly. He joined TACA in 1946 as Superintendent of Engine Overhaul; went to EAL in '47 as Senior DC-4 Maintenance Engineer.

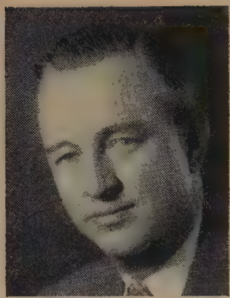
R. P. KROON, Manager of Engineering, Aviation Gas Turbine Division of Westinghouse Electric Corp., is a graduate of the Technical Academy, Zurich, Switzerland. Mr. Kroon joined the Westinghouse Company in 1931. He became Manager of Engineering of Aviation Gas Turbine Div. in 1944.

KENNETH C. GORDON has had a career in aviation that ranges from flying to selling. Now Chief Sales Engineer for Boeing Airplane Co., he began his aviation career in 1928 when he joined Boeing in the engineering weights unit. Mr. Gordon was named to his present position in 1947. U. of Wash. is his Alma Mater.

COL. ROBT. D. FORMAN, USAF, is Deputy Director of Operations for Military Air Transport Service, Washington Hq. Col. Forman entered Air Force in 1940; was Chief Pilot with China-Burma-India Div., ATC during war. In 1950 he was flown to Far East where he helped establish the Combat Cargo Command.

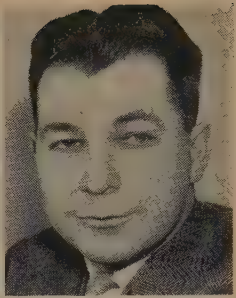
Col. R. D. Forman

G. R. Shields



Frank W. Fink

W. T. Dickinson



R. L. McBrien

Skyways Flight Operations Round Table

Problems of TURBOPROP-TURBOJET AIR TRANSPORT Operations

G. R. SHIELDS is Assistant Zone Manager, West Coast Office of the Allison Division of General Motors Corporation. He is a graduate of Purdue University and holds a BS degree in Mechanical Engineering.

FRANK W. FINK, Chief Engineer of the San Diego Div., Consolidated Vultee Corp., has been in aeronautical engineering for 24 years. During his six years at San Diego, Convair Liner, Turboliner were developed.

WARREN T. DICKINSON is a graduate of the Massachusetts Institute of Technology (1931). After work and study abroad, he joined Douglas Aircraft Co., Santa Monica Div., in 1934 and is now Executive Engineer.

R. L. McBRIEN, Development Engineer, Technical Development Division of United Air Lines, joined UAL in 1934. He is a graduate of University of Oklahoma, and has participated in numerous industry activities, among them chairmanship of SAE standardization committee.

Leslie Neville (*Director, Armed Services Technical Information Agency*): "This is the second in a series of SKYWAYS' Round Table discussions. The first one, held recently in New York, was on the subject of air traffic control. The discussion today will deal with the problems involved in turboprop and turbojet air transport operations.

"As a former aviation editor, I appreciate, perhaps a little more than others, the importance of these Round Table discussions that SKYWAYS is making possible. While most of us here live pretty close to the problems to be discussed, there are many others, both in our own organizations and outside them, who don't understand some of the problems and, of course, don't know the answers. Many of these people can and will be reached through the pages of SKYWAYS.

"The operation of jet transports offers problems that are far more complex than the public realizes. Not only are science and technology involved but also economics, international relations and other factors.

"On my flight out here to the Coast, I jotted down a few questions that might serve to get the ball rolling on the turboprop and turbojet forum:

1. Do we want or need a jet transport in the U.S.? We already have fast, economical airliners operating profitably

and providing virtually overnight service between all important cities.

2. Should we devote the jet advantage to speed, to range, to economy . . . or to what? We have increased operating speeds at reasonable rates in recent years, and each increment in speed brings new problems, both in the air and on the ground. Jet operation will require modification of many phases of air transport operations.

3. Are we going to be stampeded into jet-transport operation just because the British are operating jet transports? We must remember that the problems of the British, in terms of economics, traffic density and other factors, are very different from ours. Even the problems of our own individual airlines are different, depending on whether or not they will be in direct competition to the British airlines using the jet-powered de Havilland *Comet* in scheduled air service.

"In addition to these questions, I have some notes regarding specific factors to be considered in this turboprop-turbojet air transport problem. These factors were suggested to Ben Horchler by Charles Froesch, Vice President, Chief Engineer of Eastern Air Lines, and I'd like them read into the record.

1. Maximum speed must be related to present airport load limits and runway-length limitations.

2. Since the purchase price of a turbojet transport aircraft will be at least $2\frac{1}{2}$ million dollars per airplane, assurance must be had that such aircraft can be operated as a revenue producer.

"Under the heading of 'Specifications', comes

1. Drag devices. The jet transport should have dive brakes that will also serve as air brakes after runway contact.

2. Air Conditioning. No re-circulation of air is recommended because it has been found that this produces pilot fatigue due to the inability of present re-circulating systems to thoroughly purify the air. No sudden decompression is permissible, but if it should occur it should be gradual. This is a 'must.' Hot wall heating also is a 'must' because of low outside temperature in high-altitude operations.

3. The best in fire protection will be none too good, as jet engines are virtually pressurized burners.

4. We must design for more efficient baggage storage and handling.

5. Fuel storage in the fuselage cannot be tolerated. Wingtip tanks may be the answer, if the desired range requires them.

"Under the category designated as 'Ground Handling', Mr. Froesch remarks, 'A self-contained auxiliary power source both for taxiing and for electric power aboard is an important requisite. Such power source would be used to start the engines at the runway threshold instead of back on the ramp. In other words, a jet transport should operate on the ground without the use of any ramp equipment. Another 'must' is a low engine-noise level from the standpoint of people on the ground.' This obviously rules out afterburners, as we know them today, for thrust augmentation.

"In the way of emergency, Mr. Froesch mentions efficient evacuation chutes. Mr. Froesch's last and in many ways most important suggestion is consideration of air traffic control regulations. A study

DOUGLAS *representative at the second Flight Operations Round Table, held in Los Angeles, was W. T. Dickinson (left). Seated on his left is R. L. McBrien, United Air Lines*

MODERATOR *Les Neville (right), with R. P. Kroon of Westinghouse and Col. R. D. Forman of MATS on his right, opened meeting by listing problems up for discussion*

should be made to conform ATR's with jet operation requirements.

"There you have, gentlemen, my questions and Charlie Froesch's notes regarding turboprop and turbojet air transport operations. Mr. McBrien, how does United Air Lines feel about the situation?

R. L. McBrien (*Sr. Development Engr., UAL*): "If a 50% break-even payload factor means that which will pay for both direct and indirect expenses, I'd say that's satisfactory. If it takes a 50% payload factor to pay only direct expenses, I think that'd be pretty high."

Leslie Neville: *"How does MATS feel about this?"*

Col. Forman (*Deputy Director, Operations, MATS*): "Actually, I'm here just to listen. When it comes to the monetary value of an aircraft, I'd say that we in MATS are not the interested party. It's up to the Department of Defense to decide what they want to pay for an airplane. As far as a jet transport is concerned, we don't feel that we should walk before we crawl. We feel it would be better to start off with the turboprop transport. MATS hopes to operate turboprops sometime within the next three or four years. Lockheed is helping us out on that."

Leslie Neville: *"Nobody has mentioned the turbo-compound engine in this discussion. Is the compound engine going to delay the turboprop era? Mr. Hibbard, would you care to say something about that? You have turbo-compounds; you have turboprops coming up; and you have jets in the future. How do you feel about this sequence of powerplants as far as transports are concerned?"*

FLIGHT OPERATIONS ROUND TABLE

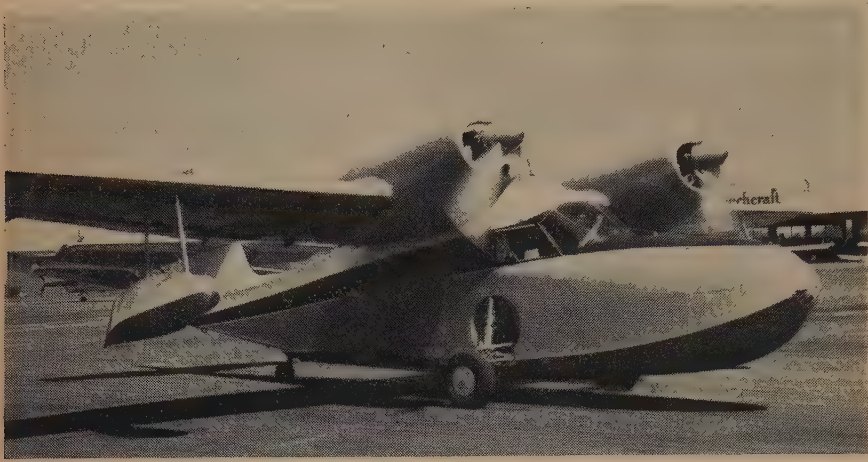
Subject: *Problems of Turboprop-Turbojet Air Transport Operations.*

Place: *Hollywood Roosevelt Hotel, Los Angeles, California.*

Hall Hibbard (*Vice Pres., Chief Engr., Lockheed*): "There definitely is a field for all of these powerplants. I think the compound engine will be with us for a number of years, and I believe that when the pure jet comes along the turboprop will go right alongside. It's a complimentary type of operation. The pure jet isn't going to chase out the turboprop, and neither is the turboprop going to chase out the pure jet. Turboprop probably will be used for carbo and coach operations. The cost per seat and ton-mile of the turboprop is definitely better than that of the pure jet. The pure jet airplane will be used for the higher speed, more or less luxury-type travel that can't be approached with a turboprop. So I believe that there very definitely is a field for all three of these powerplants."

Leslie Neville: *"Having been an observer in this field for a long time, I'm inclined to agree with Mr. Hibbard. It's largely a matter of the type of service the airlines are required to give. How about Eastern Air Lines? Charlie Froesch's notes bring up the question of first costs. Does first cost really matter or is it just operating costs?"* (*Continued on page 51*)

SKYWAYS FOR BUSINESS



GRUMMAN WIDGEON, *owned and operated by Tennessee Gas Transmission Co., is now powered by 260-hp horizontally opposed Lycomings. Lockheed Air Service did modification*

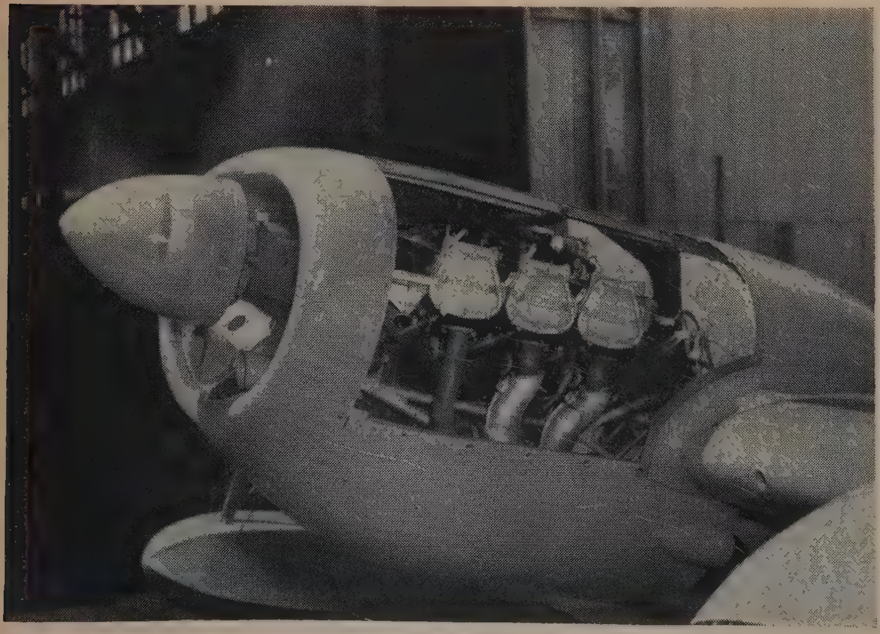
Tennessee Gas Transmission Co. Now Operating Lycoming-Powered Widgeon

Tennessee Gas Transmission Co., Houston, Texas, is now operating a Grumman *Widgeon* powered by two 260-hp Lycoming engines instead of the 200-hp Ranger engines. The Lycomings are six-cylinder horizontally opposed, whereas the old Rangers were six-cylinder in-line inverted powerplants. This change in engines required re-engineering and resulted in an increase in performance. The Lycoming-powered *Widgeon* cruises at 160 mph at 60% power. In water operations, take-off run at full gross, no wind and calm water, is half that of the conventional Ranger-powered *Widgeon*. Props on the Lycoming-powered plane are full-feathering Hartzells, and they do not touch the water at take-off power.

The new engine installation was engineered by Superior Oil Co., at a cost of about $150,000, and that company is now operating the first Lycoming-powered *Widgeon*. Tennessee Gas Transmission has the second one. Lockheed Air Service, Burbank, did the actual modifications and installations on these two *Widgeons*. It is understood that any organization utilizing the new Lycoming installation will be asked to pay Superior Oil Co., a fee to help offset the cost of the original engineering.

Anthony Zuma is Chief Pilot for Tennessee Gas Transmission Co., and he also is that company's CAOA representative. Both companies, Tennessee Gas Transmission and Superior Oil, are members of the Corporation Aircraft Owners Association.

INSTALLATION *of Lycoming "flat sixes" required much re-engineering and resulted in an increase in performance. Engineering was done by Superior Oil at cost of about $150,000*



Modification Gives the Atlas Supply Co. DC-4 27-Hour Range

Atlas Supply Company's DC-4, known throughout the corporate flying field as the "Atlas Sky Merchant," is back in operation after overhaul and modification at Grand Central Aircraft Co., Glendale, California. Modification included refueling system, installation of stub fuel tanks and a dump chute system. The DC-4 now is equipped to fly 27 hours non-stop, and is believed to have the longest range of any DC-4 in the world. Other work on the plane included a complete new paint job. The famous flags painted on its fuselage, representing the 48 states and 52 foreign countries it has visited, were obliterated when the plane stripped of its old paint on the wash rack. These, however, were replaced in authentic colors. Col. Edwin E. Aldrin, manager of the aviation department of Atlas Supply Co., Newark, New Jersey, directed the work on the plane at Grand Central.

It is estimated that half a million people have inspected this corporate plane at the hundreds of airports throughout the world where it has stopped to exhibit the company's products of aviation accessories.

New Detergent and Water System Saves Man-Hours in Plane Wash

Development of a new water pipe and drainage system and a new detergent formula have enabled United Air Lines to save from 50% to 67% in man-hours per plane wash. Aircraft to be washed are parked on a concrete apron which has a storm drain and underground water pipes with outlets at 100-foot intervals. Wings and fuselage of the plane are "soaped" with a special detergent, Formula 2844, developed by Turco Company of Los Angeles. This detergent is applied at 20 lbs. pressure from a half-inch hose. Rinse water under 100 lbs. pressure then is sprayed over the plane from a one-and-a-half-inch hose. Feature of the cleaning detergent is that in addition to removing grime of all kinds, it dries so slowly that it can be applied in direct sunlight and has no corrosive effect on the "sealer" and the aluminum surface of the aircraft.

UAL estimates its wash crew can do a job in two hours, 45 minutes that formerly took eight hours.

Plan Set Up for Civil Flying in Case of National Emergency

A plan which will permit the maximum of civilian and military flying consistent with national defense requirements during a military emergency, has been adopted by the joint Chiefs of Staff in collaboration with CAOA and representatives of other civil aviation groups.

Three warning conditions are established, Warning White, Warning Yellow, and Warning Red. Under each, a set of rules governing civilian and military non-tactical flying inside and outside of the Air Defense Identification Zones is established, with provisions made for keeping the duration of the yellow and red warnings as brief as the actual military situation will allow. Military and civilian representatives on the Air Defense Planning Board have agreed that the rules represent minimum interference with civilian flying while the military is carrying out its duties of detection, identification, interception and destruction of a potential enemy.

Detailed information regarding all the restrictions that can be imposed on corporate aircraft operations during such a national emergency can be obtained either through the Civil Aeronautics Administration, or CAOA headquarters, 1029 Vermont Ave., N.W. Washington, D.C.

Resentment of Low-Flying Aircraft Grows in New York Area

It is hoped that all pilots recognize the seriousness of low-flying activities, particularly adjacent to large terminal airports. Public resentment is critical in the New York Metropolitan area. Communities neighboring Idlewild, LaGuardia, Newark and Teterboro Airports are banding together to consider ways and means of closing or restricting all flight operations. The seriousness of this situation cannot be minimized and all pilots are asked to become entirely familiar with current flight patterns in and out of all airports throughout the country.

Captain Eddie Rickenbacker, Chairman of the National Air Transport Coordinating Committee, believes that many complaints could be eliminated and the situation eased if pilots conduct operations to and from Idlewild Airport as follows:

1. On approach, maintain highest possible altitude for as long as possible before descent to the airport.
2. On departure, attain an altitude of at least 1200 feet in shortest possible time.
3. Avoid low turns and banks over communities adjacent to airports and conduct operations over open areas wherever possible.

All three of these suggestions must, of course, be accomplished within the limits of safe operations.

Pilots flying in the Metropolitan area can do much to help alleviate the existing pressure by following the above suggestions.

. . . in the Corporate Hangar

Eddy Ross, one of Continental Oil Company's pilots, stopped at Southwest Airmotive at Dallas, Texas, to show off Continental's new airplane, an A-26. The '26 is based at Ponca City, Oklahoma with the other aircraft in Continental's fleet. Continental Oil Company is a member of Corporation Aircraft Owners Association.

Curt Talbot, Gene Beattie and Buell Warner, crew of General Electric Company's Douglas B-23, brought the executive transport to AiResearch from Schenectady, N. Y., for annual relicense and 100-hour inspection. AiResearch installed an Edison fire detection system in the '23 and fabricated and installed a new instrument panel. Engines also were changed. GE holds CAOA membership.

A contract for inspection, repair and maintenance of CAA Region I's DC-3 was awarded recently to Lockheed Aircraft Service-International at N. Y. International Airport. The contract runs for one year.

Sears Roebuck Company's DC-3 has been in the hangar at AiResearch for overhaul and an engine change. Pilots Vic Swanson and Ed Van Sickle flew the plane out from Chicago. Vic is Sears' CAOA representative.

General Mills' DC-3 is also in the hangar at AiResearch. Pilots Harry Nystrom and Bill Stone flew the ship out from Minneapolis for a major 800-hour inspection and a complete overhaul. Work on the DC-3 includes a new executive interior, radio installation and prop overhaul.

Corporate pilots are meeting these days at SAC, Love Field, Dallas. Kenneth R. Unger brought Johnson & Johnson's Lockheed 18 in for minor repairs. Also at SAC were Stanley Tananbaum of New York City, and Brinkerhoff Drilling Company's Martin Weirauch and Jack Earlywine were in from Casper, Wyoming.

International Paper Company's *Lodestar* has been at the Burbank base of Lockheed Aircraft Service for recertification, overhaul of the hydraulic system and tank resealing.

Add the following new executive planes to the corporate fleet: Commonwealth Motors, Inc., of Richmond, Va., bought a D18S from Powers & George; Lion Oil Co. of El Dorado, Ark., bought an executive *Lodestar* from L.B.S. Aircraft; and the Bowers Battery and Spark Plug Co., of Reading, Pa. now have a Twin-Beech.

Union Oil Company's B-23 is at Pacific Airmotive, Burbank, Calif., for major changes. Work includes installation of outer wing fuel tanks to increase the B-23's range. Dump shutes also are being incorporated. The plane is also getting a double engine change, new paint job, new baggage compartment and door, installation of a new de-icing system, and installation of a new instrument panel.

Remmert-Werner's at St. Louis is also enjoying a gathering of the pilot clan. Neil Fulton brought the Mathieson Chemical Corporation's DC-3 in from Baltimore for 1,000-hour overhaul and a paint job; Howard Zbornik flew the Celanese Corporation's '3 in for an elaborate radio installation; and Art Chapman, Ed Elliott and Mike Sandors, Goodyear's pilots, brought Goodyear's DC-3 in for 1,000-hour overhaul and a paint job.

George Pomeroy, pilot for Swiftlite Aircraft Corp., has his company's DC-3 back in operation after a trip to AiResearch at Los Angeles. An "Air-stair" door was installed on the DC-3. George is Swiftlite's CAOA representative.

Fruehauf Trailer Company has its converted PV-1 in operation and the company's second PV-1 is due to fly soon, if it hasn't already. The second PV-1 was in its final stage of conversion recently and was about to have a Sperry A-12 autopilot installed and a paint job. Remmert-Werner is doing the work.

Chuck Wheeler, chief pilot for Diamond Alkali Company, has the company's new DC-3 in operation after an executive conversion at Beldex Corp., in St. Louis.

CAOA report

CORPORATION AIRCRAFT OWNERS ASSOCIATION, INC.

Corporation Aircraft Owners Association is a non-profit organization designed to promote the aviation interests of the members firms, to protect those interests from discriminating legislation by Federal, State or Municipal agencies, to enable corporation aircraft owners to be represented as a united front in all matters where organized action is necessary to bring about improvements in aircraft equipment and service, and to further the cause of safety and economy of operation. CAOA headquarters are located at 1029 Vermont Ave., N. W. Washington 5, D.C. Phone: National 0804.

Executive Director Named

The Board of Directors of the Corporation Aircraft Owners Association, Inc. has appointed Jean H. DuBuque as Executive Director and Secretary of the organization. He resigned as Special Assistant to the Under Secretary of Commerce for Transportation to accept the appointment.

Mr. DuBuque has held previous posts as Special Consultant to the Secretary of the Air Force; Director of Aviation for the City of Dallas, Texas; Director of Advertising and Public Relations for Lear, Inc., Assistant to the Sales Manager of Beech Aircraft Corporation, and other key positions with the airlines and Federal and State governments.

A veteran flyer, Mr. DuBuque has been active in aviation affairs for over 20 years. He entered the private practice of aviation and public relations consulting in Dallas, Texas in 1946. He moved his offices to Washington, D. C. the following year where he served as counsellor on public and governmental relations to various national aviation trade associations. He returned to Federal service in 1948 when he accepted an appointment in the Office of the Chief of Staff of the Army, directing public relations activities for the Reserve Forces and Reserve Officers Training Corps.

NEW *Executive Director is Jean DuBuque*

In 1951, Mr. DuBuque transferred to the Department of Commerce as Special Assistant to the Under Secretary of Commerce for Transportation and remained in that post until his present appointment.

During World War II, Mr. DuBuque served as a Squadron Commander in the Army Air Forces. Later he was assigned to the air staff in Washington as special technical advisor in air intelligence and plans. Upon leaving the military service in 1945, Mr. DuBuque became Special Assistant to the Director of the Aircraft Division, War Production Board. While in that post, he also served as a radio commentator on air warfare for the Office of War Information, broadcasting weekly to the various theaters of war.

Prior to volunteering for active duty as a Captain in the Army Air Corps a month before Pearl Harbor, Mr DuBuque was Branch Manager of Aero Insurance Underwriters in Chicago, Illinois. From 1936 to 1941, he served as an Airport Engineer for the former Bureau of Air Commerce in Region III, and as a Ground School and Flight Supervisor for the Civil Pilot Training Program of the Civil Aeronautics Authority in Region IV.

Co-author of a two-volume set of aviation training texts with world-famous pilot, Colonel Roscoe Turner, Mr. DuBuque also has written many articles for newspapers and magazines on aviation and technical subjects.

Mr. DuBuque is a member of the Institute of the Aeronautical Sciences, the Air Reserve Association, Quiet Birdman, American Public Relations Association, American Legion, and many other technical and professional organizations.

Statistics on Corporation Flying

Cole H. Morrow, Board Chairman of CAOA, recently came up with some surprising information regarding the scope of corporation flying around the nation. At present, over 1500 multi-engine aircraft and about 7,000 single-engine aircraft are owned and operated by large and small corporations. During 1951, corporation and business flying amounted to 2,986,000 hours compared to the 2,254,000 hours flown by all the domestic airlines. In addition, the combined seating capacity of corporate aircraft alone presently exceeds the total number available in all the airlines. This is certainly an outstanding indication of rapid growth and progress in the field of corporation flying.

Mr. Morrow also pointed out that in the past it was the general viewpoint that scheduled air transportation was the only major factor in civil aviation. Numerous communities that constructed airports with the hope that they would qualify for airline service suffered sharp disappointment when it was not forthcoming. On the other hand, the ever-increasing amount of corporation and business flying has done much to fill the dwindling coffers of off-airline municipal airports as well as those of private fixed based operators. Obviously, in any future national airport planning, consideration should be given to developing adequate facilities to meet the requirements of corporation and business flying. Since corporation flying provides fast transportation when and as required, the lack of adequate airports will hamper to a marked extent the development of its full potential.

The Vanishing Airport

A matter of serious concern in the civil aviation industry today, particularly to corporation aircraft owners and operators, is the decreasing number of airports throughout the country where service and maintenance can be obtained on cross-country flights. Statistics reveal that more than half of the nation's small airports have vanished over the last decade. Many of the larger municipal airports also are being gobbled up for defense purposes.

The recent announcement by the Air Force of its fiscal 1953 air base program, involving the acquisition of 36 municipal airports, is a serious blow to fixed base operators who are the backbone of civil aviation activities. A spokesman for the Air Force indicated that cognizance would be given only to certificated air carrier operations currently existent on the airports being taken over. Fixed base operators would be permitted to remain only if there is no other place for them to go.

It is undeniable that the needs of national air defense must be recognized and met if we are to survive as a democratic country, but it also is true that the civil aviation industry must not suffer as a consequence.

In the recommendations of General James H. Doolittle, Chairman of the President's Special Airport Commission (page 20, recommendation 23), the following significant statement was made:

"Separate military and civil flying at congested airports. Military aircraft should not be based on congested civil airports except when it is not economically or otherwise feasible to provide separate facilities for them nor should commercial aircraft operate regularly from busy military airports."

The language of this recommendation is certainly clear and specifies that the *Air Force should construct and maintain its own bases,* apart from the civil airport. Of course the "not economically or otherwise feasible" permits a broad interpretation.

CAOA has taken a definite and very strong stand along with other aviation associations with regard to the emasculation of civil aviation by the arbitrary taking over by the Air Force of civil airports without adequate provisions for the requirements of civil aviation. It is CAOA's firm conviction that one of the greatest limitations in corporation and business flying today is the lack of adequate airports and facilities in communities which have industrial business activity best contacted and served through the use of air-

craft. If the Air Force continues its acquisition program along present lines, the future prospects of civil aviation growth indeed look dark.

CAA Proposes Revision of Runway and Taxiway Marking

In order to improve current runway and taxiway marking by incorporating the latest developments in this field of visual guidance, the CAA has formulated new requirements for marking runways and taxiways on civil airports. Recent experience with very low minimum approaches and landings, using modern electronic landing aids, has demonstrated that certain new supplemental runway-marking elements can provide additional guidance to the pilot, thereby increasing safety for such operations.

The revised system recognizes that the amount of runway marking required depends upon the operational minimums, electronic aids, and other factors associated with that runway. Accordingly, this system is divided into three groups of markings to accommodate the three classes of operational minimums, taking into consideration economy of installation and maintenance.

All elements of the proposed system have been checked by pilots, engineers, and airport operators; and operational experience with experimental installation of these elements has proved very satisfactory.

The issuance of the proposed runway-marking standards will not make this marking mandatory on civil airports. The additional guidance provided by the three types of runway markings, however, will produce increased safety and the CAA will recommend that the applicable marking be installed wherever practicable. In cases where funds exist, Federal Aid may be available for installing the marking.

Original cost of installation and maintenance has been carefully taken into consideration in the drafting of the runway-marking system and the system proposed is considered to provide optimum guidance consistent with economy of installation and maintenance.

In order to achieve comprehensive coordination of the proposed runway-marking standards with all civil aviation groups concerned, the standard is being sent to all operational and airport management groups.

Outstanding Safety Record

Service Pipe Line Company of Tulsa, Oklahoma, recently provided CAOA National Headquarters with some interesting data on their flight activities. They operate five multi-engine aircraft for passenger service and five single-engine planes for patrolling pipelines. During the past six years, ending June 30, 1952, the Aviation Section of the company operated with a total of 22 employees, working 275,000 man-hours, without a disabling injury. A total of 4,313,097 air miles and 8,354,374 passengers miles were flown by the 10 aircraft during that time.

Visitors of CAOA Headquarters

John J. Sheehan
Civil Aeronautics Board
Washington, D. C.

Claude O. Witze
Piasecki Helicopter Corp.
Morton, Pa.

John R. Anderson
Lord Mfg. Co.
Erie, Pa.

Galen P. Potter
AiResearch Aviation Service Co.
Los Angeles, Calif.

Jack Purcell
Aircraft Industries Assoc.
Washington, D. C.

Harry G. Barnes
Civil Aeronautics Administration
Air Route Traffic Control Center
Washington, D. C.

Charles B. Culbertson
S. C. Aeronautics Commission
Columbia, S. C.

R. W. Lane, Chief Pilot
Food Machinery & Chemical Corp.
San Jose, Calif.

Michael J. Oppice
Accessory Overhaul Industries
Richmond Hill, N. Y.

Ken Klippel
Collins Radio Co.
Cedar Rapids, Iowa

BURLINGTON MILLS' *Pilot Jim Guess (right) and Copilot Dick Vaughan brought company Twin Beech into Teterboro Airport, N.J. recently. Based at Greensboro, N.C., the Twin Beech is equipped with VOR, ILS, ADF, Marker Beacon, etc., and is flown between 50 and 80 hours each month. Chief Pilot S.M. Maxwell is Burlington Mills' CAOA representative*

CAOA Calendar and Associated Events

Oct. 9, 10, 11—	Cole H. Morrow, Chairman of the Board of Directors for CAOA, will be official representative at the International Northwest Aviation Council 16th Annual Convention, Great Falls, Mont.
Nov. 17, 18, 19—	Jean DuBuque, Executive Director of CAOA, will represent CAOA at the NATA meeting in Los Angeles.
Nov. 18, 19, 20, 21—	Jean DuBuque will represent CAOA at the NASAO meeting in St. Petersburg.

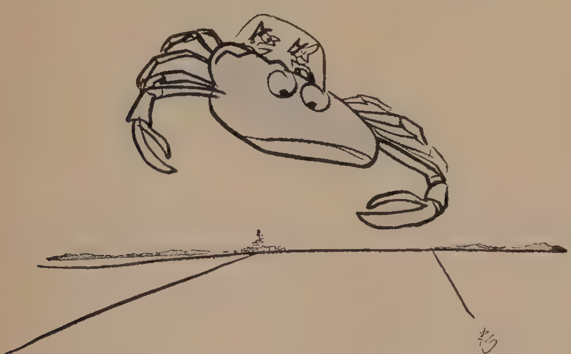
KRAFTEX *B-25 also stopped at Teterboro. Don Ice and A.A. Andresen were at controls*

Performance

from the Files of the Flight Safety Foundation

Coffee Klotch

A pilot on a long hop in a twin-engine aircraft was served a cup of coffee. He took a sip or two, then set the cup on top of the control pedestal. One "bump" later, the coffee spilled and created a short circuit in the pedestal's internal mechanism!



Crosswind Landing

Here are some acts judged by check pilots as frequent errors occurring on flight checks:

1. Landing in crab or skid, without correcting for drift; drifting over runway.
2. Poor alignment with runway on approach; over-correction or poor drift correction.
3. Approaching too fast.
4. Not holding heading on landing roll.
5. Using stall-type landing; getting nose wheel on too late.
6. Landing with wing down or on one wheel.
7. Approaching too slowly.
8. Using too little rudder; poorly coordinating throttles or controls at touchdown.
9. Not using aileron to compensate for "roll" on landing; using ailerons improperly.
10. Using too little or too much flaps.

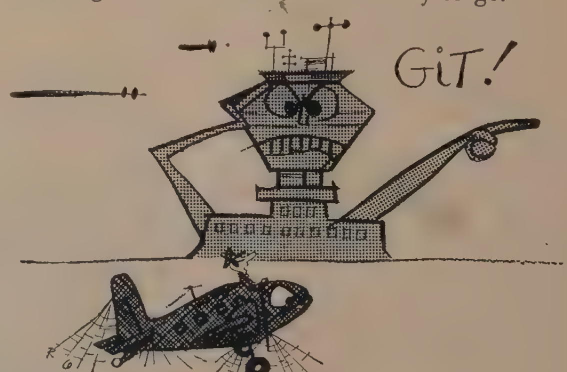
Tower Talk

As Control Tower personnel are in an advisory capacity only, their "instruction" may seem more like "suggestions." If the urgency of the "suggestion" is not grasped by the pilot, a dangerous situation can result. Here's one of the more frequent "misunderstandings:" Control Tower clears you for *immediate* take-off (another plane may be on its way in to land and a delay in take-off may bring the landing plane too close for comfort). But, the pilot, not recognizing the importance of the word, "*immediate*," delays to do some final checking. The result is confusion that is apt to cause a critical condition:

1. The minimum separation for safety between aircraft may not be maintained and a hazard exists—the landing aircraft is descending on the aircraft in take-off position or the landing aircraft is descending into the turbulence of the take-off plane's prop-wash.
2. The aircraft in take-off position may start down the runway and climb into the "landing" aircraft which has received a "go-around."

At these critical moments quirks of radio reception may result in a loss of contact, and further warning can't be given.

BUT . . . and it is a big "but," it is even more dangerous to rush a pre-take-off check. Moral: be sure you are completely ready to take off before advising the tower that you are ready to go.



Pre-Take-Off Procedures

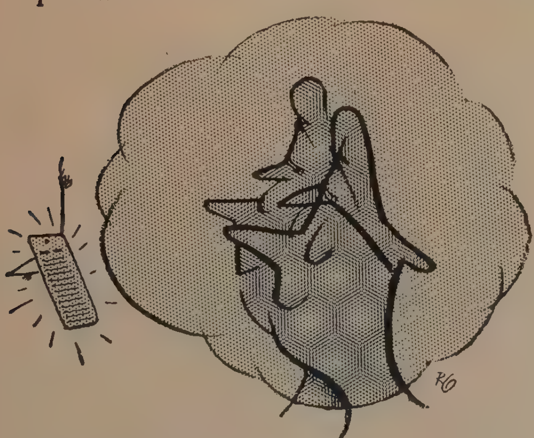
Here are some commissions and omissions in pre-take-off procedures judged by check pilots as

PITFALLS

by Jerome Lederer and Robert Osborn

frequent errors occurring on flight checks:

1. Not checking all items; overlooking inoperative or malfunctioning instruments or other equipment.
2. Not checking controls through fullest extent of travel.
3. Running engine up improperly, hastily or roughly.
4. Not using check-list or a routine checking procedure.
5. Hurrying magneto check or handling mag switches improperly; hurrying ignition check; not checking rpm drop; exceeding manifold pressure.
6. Positioning plane improperly; not heading into the wind.
7. Rushing through check-list.
8. Aligning plane so as to blast other planes.
9. Not checking oil temperature or waiting for oil pressure to reach limit.
10. Not checking for other planes before taking runway; not moving plane to observe other planes.



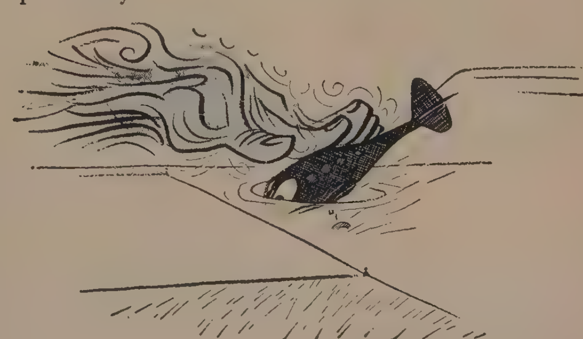
Food Poisoning

On a stop-over at mid-day while on an executive flight, a pilot and copilot went to a nearby restaurant for their lunch, having arranged previously for their passengers to have lunch on board the airplane. About 45 minutes after take-off, the copilot began to feel ill and grew progressively worse and was unable to assist the pilot during the landing. He had to be hospitalized for several days as a result of food poisioning. Fortunately, the chief pilot hadn't eaten the same thing for lunch. If he had, a serious accident might have resulted.

Since this incident, the company has followed the policy of always having two qualified pilots on board the airplane for every flight, and when the pilots have occasion to eat just prior to departure, they avoid foods which are easily contaminated.

Prop Blast

A small executive-type airplane flown by a competent pilot suddenly dove into the water near the end of the runway while making a landing approach. Informed sources indicate the probable cause of the tragedy was loss of control: the pilot had flown into the backwash or slipstream of an air transport which had taken off about a minute previously.



What about THUNDERSTORMS?

CAOA pilots gather at St. Louis for discussion of thunderstorms

▶ "Thunderstorms, with their hail, lightning and icing conditions, are the principal obstacles to flying in the summer. This is especially true in the Midwest. There is no such thing as a mild thunderstorm and the 'rule of 180' is still the wisest for all pilots," the St. Louis Division of the Corporation Aircraft Owners Association was told recently by Major William Best, USAF thunderstorm specialist and director of operations, headquarters, Air Weather Service, Andrews Field, Md.

Some 100 executive pilots, corporation officials, and guests attended the gathering at the Officers Club, Naval Air Station, located adjacent to St. Louis' Lambert Field. The meeting was jointly sponsored by government and industry representatives.

Appearing with Major Best, the principal speakers at the evening meeting were Lt. Col. Templeton S. Walker, director of plans, USAF Air Weather Service, and Major James H. Titsworth of the office of director of plans, USAF-AWS, Andrews Field, Md.

Cole Morrow, chairman of CAOA's Board of Directors, and Harley Clapsaddle of the CAA's general operations branch, Washington, D. C., also attended the meeting.

Major Best's speech was based principally on knowledge gained from the joint Air Force, Navy, NACA and U.S. Weather Bureau thunderstorms project, undertaken in 1946-47, in which pilots flying P-61's equipped with special instruments made nearly a thousand deliberate passes through thunderstorms. "This research proved beyond a doubt that safe flight through thunderstorms could be made," said Major Best, "assuming sufficient planning and skill."

A fly-safe program in thunderstorms areas calls for three things, Major Best said. They include sensible flight planning on the ground before take-off, sensible flight planning in the air after take-off, and, when required, skillful instrument flying through thunderstorms.

The purpose of flight planning before take-off is to avoid thunderstorms if at all possible, and if this is impossible, then to avoid areas and altitudes of maximum turbulence, hail, lightning and icing. To fly safe, the pilot should do four things:

1. Check with the weather forecaster on existing and forecast thunderstorms areas. The forecaster will be able to advise whether thunderstorms will be of the air-mass or frontal type and he will help select a route to avoid them.

2. Check on reports of Storm Detection Radar, if available. This is the AN/APQ #13 ground radar that pinpoints thunderstorm activity within a radius of 75 miles. The Air Weather Service has 70 such installations in the continental United States. While they are operated by Air Force observers for USAF, many of their reports are put out on the civil AWS circuit, and are available in civil weather stations.

3. He should know the present and forecast height of the freezing level. This is extremely important because, in thunderstorms, a maximum of turbulence, hail and heavy icing, and lightning strikes occurs at and slightly above the freezing level.

4. Know the present and forecast bases of convective and particularly cumulo-nimbus clouds en route. The least turbulence, hail icing and lightning strikes occur at flight altitudes near the cloud base.

The purpose of flight planning after take-off is the same as before take-off—to avoid thunderstorms. If this is impossible, then it is helpful in choosing the safest areas.

When airborne, the pilot depends on his eyes to tell him when and where to go. For this reason, he should know the life cycle of a thunderstorm and how it looks in its various stages.

The thunderstorm Project proved that a thunderstorm is actually made up of separate cells, each with its individual circulation.

Each cell is from one to five miles wide, and progresses through a life cycle lasting from one to three hours. The life cycle consists of three stages: (1) the cumulus, or building, stage, (2) the mature stage (3) and the anvil, or dissipating stage.

The appearance of a storm cloud from a distance indicates its stage of development and its probable degree of violence. An intensifying thunderstorm has a sharp-edged cauliflower appearance and a predominance of sharp, vertical, cloud-to-ground lightning. Such a storm has a maximum of updrafts, turbulence, and hail. On the other hand, a thunderstorm already past its prime has an anvil top, and a predominance of horizontal cloud-to-cloud lightning. This decaying storm has a maximum of downdrafts, and less turbulence and hail associated with it.

Thunderstorm research has also shown that turbulence is highly correlated with precipitation. For this reason, heaviest turbulence is found where the darkest rain columns exist.

It is worth noting that this relationship between intensity and precipitation and turbulence is the reason why airborne radar is so successful in thunderstorm navigation. The radar echo, of course, is the reflection of the heavy moisture area. The benefits of airborne radar are two-fold:

1. The psychological effect of having a radar aid on board reduces tension on the part of the pilot and avoids a tendency to over-control the airplane.

2. The practical advantage of being able to avoid areas of maximum turbulence. Thunderstorm gusts encountered within the radar echo are four to five times more severe than those outside the echo.

While such equipment may not be generally available now, the advantages of having it are worth keeping in mind.

As mentioned before, the optimum altitude is just below the base of the cloud and between the rain columns. At all costs, avoid an altitude near the freezing level, for there

PLANNING COMMITTEE *of the Corporation Aircraft Owners Association group at St. Louis are (left to right) Lee Dorrance, chief pilot, Gaylord Container Corp.; Sid McCullough, CAA; Ralph Piper, chief pilot, Monsanto Chemical. This committee set up the meeting*

turbulence, icing, hail and lightning strikes are at a maximum.

Major Best stated that in addition to the hazards of reduced ceiling, visibility and wind gusts, if a landing is attempted during a thunderstorm, there may be considerable altimeter error because of erratic fluctuations in air pressure. In the Thunderstorm Project, pilots landing who had reset their altimeters only 10 minutes earlier, found them to be in error by 60 feet or more about half the time.

If the pilot finds that despite all these efforts, he still must fly through the thunderstorms, then it was Major Best's recommendation that he keep in mind the following "Do's" and "Don'ts":

1. Have proper airspeed. At lower airspeeds, turbulence and hail impact impose less structural stress on the airplane, but controllability is reduced. At higher airspeeds, you have greater control over the airplane, but chance of structural failure is increased. Opinion here differs somewhat among aircraft manufacturers and pilots as to safe penetration speeds for different aircraft. As a general rule, the best penetration speed seems to be about 60% above stalling speed.

Proper airspeed must be established before going on instruments, and thereafter the established power setting and pitch altitude should be maintained, regardless of indicated airspeed. This is because indicated airspeed is extremely erratic during thunderstorm flight. Rapid changes in horizontal gust velocity or rain blocking the pitot tube pressure head, for example, may fluctuate the indicated airspeed reading by as much as 70 mph.

2. Increase propeller rpm to maintain engine temperatures, get quicker reaction from power changes, and obtain additional gyroscopic stability.

3. Turn pitot heat on. Apply carburetor heat, if required. Check de-icing equipment. In a thunderstorm, flight-level temperature may drop approximately 4°. As a result, you may pick up ice where you are led to expect none. In general, icing is not too serious a hazard if you avoid altitudes near and above the freezing level.

5. Turn on cockpit lights to lessen chances of being blinded by lightning. Wear dark glasses.

6. Turn off electrical equipment not necessary for flight, to minimize effect of lightning discharges. Slide headset off your ears slightly to lessen effect of crash static.

7. Fasten safety belts.

8. Fix your position accurately before entry. Precipitation static and crash static will render most radio equipment useless.

After entering the storm, then:

1. Never turn around after you have penetrated. You may get lost and it is a control maneuver that adds its own load to he gust load.

2. Fly manually, with airplane trimmed for straight and level flight and gear and flaps retracted. Allow the airplane to ride out all angular and linear displacements caused by drafts and gusts. Avoid over-control. Beware of trying to hold altitude by nose-high or nose-low attitudes. Such attitudes, combined with rapid and erratic airspeed changes that often occur, can cause a spiral dive or a stall.

Throughout the Midwest where terrain is flat, there is little danger of thunderstorms downdrafts carrying an airplane into the ground. Experiments in the Thunderstorm Project showed that thunderstorm downdrafts spread out horizontally at around 2,000 feet above the ground. In other words, the lowest 2,000 feet of the atmosphere acts as a sort of cushion, through which thunderstorms downdrafts do not penetrate. If, however, action is necessary to correct for a dangerous change in altitude, only a minimum pitch correction should be made. Again, the real danger is going into a dive or a stall rather than being kicked up or down by the drafts.

3. Cross check instruments frequently, since certain instruments become momentarily erratic during thunderstorm flight.

Major Best concluded by saying there is no substitute for good judgment on the part of the pilot in avoiding or, if necessary, penetrating thunderstorms. In order to be in a position to exercise good judgment, however, the pilot must, first, know the over-all weather picture before leaving the ground; second, be aware of potential developments so he can recognize and evaluate them properly when they loom ahead of him; and third, know how to penetrate thunderstorms in his particular type aircraft with a minimum of risk. Only in this way, through a combination of pre-flight analysis on the ground and in-flight analysis in the cockpit, can the hazards of thunderstorms flying be kept at a minimum.

Aero Commander

(*Continued from page 13*)

was a 25-mile 90° crosswind at Teterboro for our final landing and, except for a slightly higher speed, the landing was made normally. Short-field landings are made about the same as on normal landings, but with power and an over-the-fence speed of 70 mph. Throttles should be closed as soon as main gear makes contact and maximum braking should be applied as soon as the nose gear touches.

Engines and Props

No evaluation of the *Commander* would be complete without comment on the powerplants. The *Commander* is powered by two Lycoming GO-435-C2 six-cylinder, horizontally opposed, aircooled, geared engines having a piston displacement of 434 cubic inches and a compression ratio of 7.3 to 1. Engine-propeller ratio is 120 to 77. With a constant-speed, full-feathering propeller, the engine delivers 260 hp at 3400 rpm for five minutes and has a maximum continuous rating of 240 hp at 3,000 rpm. On all standard models of the *Commander*, the right engine is equipped with a vacuum pump and the left engine has a hydraulic pump and a generator.

Taking a leaf from the book of designers on the Convair 240, the Aero *Commander* engineers specified an exhaust augmentor on each of the Lycomings. Those on the *Commander* are the first to be installed parallel with the thrust line. They are longer in relation to powerplant size than augmentors on any other plane. The augmentors cut engine cooling drag, providing efficient air and exhaust pumping. It is estimated that the augmentor exhaust system on the *Commander* has reduced engine cooling drag by about 50%. The augmentors reduce exhaust back pressures and provide a slight power increase.

Each engine has a Stromberg PS-5BD carburetor incorporating automatic mixture control units and it is, therefore, not necessary to manually lean the mixture in flight. These pressure carburetors are fully automatic and always remain in full forward position, adjusting for changes in pressure and providing the most efficient mixture. I liked, too, the five-tank fuel system of the airplane. It operates like a one-tank system, the only fuel management being the fuel shut-off valves and the fuel boost pump for take-off and landing. Fuel from the four outer-wing tanks is gravity fed into the center tank and from that tank to the carburetor by engine-driven pumps. The *Commander* uses 80-87 Octane fuel and has a capacity of 145 gallons.

The *Commander's* propellers are constant-speed, full-feathering Hartzells, with pitch governed by the controls in the center of the quadrant to the right of the throttles. When the controls are full forward, the propeller is set in full low pitch. When the controls are in extreme aft position, the propeller is in full high pitch. Setting the controls at any pitch between these two extremes selects the desired intermediate engine speed.

The main gear of the *Commander* is a modified hydraulic-retracting version of the service-tested BT-13 trainer gear and the nose wheel was adapted from the *Navion*. Main gear wheels are equipped with Goodyear single-disc brakes.

I found several items which almost any pilot would criticize, but I am happy to report that practically all of them are corrected.

Commander Equipment

The designers of the *Commander* attempted to come as close as possible to the standard cockpit arrangement recommended by the joint Air Force, Navy and CAA board, but I had some difficulty reading the upper portion of the recessed dials. One of the many good features of the cockpit is that control levers are identified with the parts they actuate, such as an air foil on the flap control and a disc on the landing gear control.

Instruments are rubber shockmounted but I believe further work on vibration control should be done and many miscellaneous items beefed up structurally. Cabin ventilation, inadequate in the airplane I flew, is being corrected by engineering. I understand, too, there may be some redesign of the window within the window on the pilot's side. It rests on the ledge at the base of the windows and I feel it could be a source of trouble for the entire window. Be careful not to extend your arm too far out of the pilot's window as you may remove part of your hand on the left prop. The noise level in the cabin is higher than necessary and considerable soundproofing is being done to correct this problem.

The standard *Commander* is arranged to accommodate five persons and there is space for a sixth seat if it is desired. All seats are adjustable, except the rear one against the back wall of the cabin. I feel that the two passenger seats immediately aft of the pilot's and copilot's seats are cramped and would not be comfortable over long distances.

The high-wing configuration of this airplane offers many distinct advantages. With the cabin floor only 19.5 inches above the ground and a door measuring 45 by 29 inches, it is easy to step into and out of the *Commander*. The cabin measures 102 inches from the picture-window windshield to the back of the rear seat.

Visibility is about the best I have ever seen in an airplane of this type. In addition to the large windshield, there are six other large windows. There are 3,280 sq. in. of window area, more than in most later-model automobiles.

Maintenance on this airplane should be wonderful from the mechanic's standpoint. Access doors and easy removal of all cowling without the necessity of stepladders or ramp stands allows, as an example, all engine work to be done from a normal standing position on the ground.

Standard equipment on the *Commander*

TEST PILOT *Herb Fisher demonstrates how easy it is to enter the cabin of the Aero Commander. Floor of the cabin is just 19 inches from the ground and the door is of ample width*

includes: Flight Group—airspeed indicator, altimeter, rate-of-climb, two turn-and-bank indicators (one electric and one air-driven), artificial horizon, directional gyro, clock, magnetic compass. Engine Group—tachometer (dual-type), manifold pressure, two sets of engine-gauge units, hydraulic pressure gauge, ammeter, fuel quantity gauge, vacuum gauge. Radio—Lear VHF transmitter and receiver, one overhead loudspeaker. Optional equipment includes Lear automatic pilot, Narco Omni and VHF, complete ARC installation, Lear ADF and ILS, marker beacon receiver, stall warning, pilot's pull-down curtain, platinum plugs. Miscellaneous equipment classified as Standard include flap position indicator, landing gear position indicator, flasher-type position lights, Janitrol heater (25,000 BTU capacity), landing lights, map light and dome light.

I believe the Aero *Commander* will set a new high standard of performance for twin-engine executive airplanes and do it economically. The Standard 520 *Commander* is now selling for $66,000. This price, like most prices today, is subject to change.

The *Commander* fills a need for fast, efficient transportation of passengers or cargo. It is the light, fast, easy-to-operate airplane corporate operators have been waiting for.

Specifications:

All performance based on full gross load of 5500 pounds. Speeds guaranteed within 3% plus or minus. Climb data guaranteed within 10% plus or minus.

Gross Weight .... 5,500 pounds
Empty Weight .... 3,640 pounds
Fuel Capacity (standard).... 145 gallons
High Speed—
Rated Power S.L. ....211 mph
Cruising Speed—
70% S.L. Power
@ 10,000 ft. ....197 mph
Rate of Climb—2 engines
Normal Rated Power S.L. ....1700 fpm
Rate of Climb—1 engine
Normal Rated Power S.L. ....400 fpm
Service Ceiling—2 engines ....24,000 feet
Service Ceiling—1 engine
(windmilling prop.) ....8700 feet
Service Ceiling—1 engine
(feathering prop.) ....10,500 feet
Take-off Distance over 50-ft.
Obstacle ("0" wind) ....950 feet
Stall Speed @ S.L.—
Full Flaps Power Off ....60 mph
Stall Speed @ S.L.—Flaps
and Gear Retracted ....67 mph
Stall Speed @ S.L.—
Full Flaps Power On ....40 mph
Powerplant
(2) Geared Lycoming GO-435-C2
Take-off Rating
(5 minutes rating) ....260 hp
Normal Rated Power ....240 hp
Engine rpm (At Normal
Rated Power) ....3000 rpm
Propeller rpm (At Normal
Rated Power) ....1925 rpm
Range (with standard fuel
capacity at 60% power
and 30-minute reserve) ....1150 mi.

The above performance is based upon International Standard Atmosphere, and upon the engine powers specified in the engine manufacturer's power curves. Single-engine performance is based upon the use of full feathering propellers.

Prices

Commander 520
(Standard) $66,000.00

Optional Equipment:

Lear Automatic pilot.... 5400.00 installed
Narco Omnigator
(includes VHF Trans.
& Rec.) .... 1150.00 installed
Complete ARC
installation ....6500.00 installed
Lear ADF ....1195.00 installed
Dual Lear ADF's .... 2300.00 installed
Marker Beacon Rec. .... 250.00 installed

Miscellaneous

Extra Chair,
upholstered (same
as pilot chair) ....$350.00 each
Pilot Pull Down
Curtains .... 35.00 each
Platinum Plugs
(installed) .... 108.00 per set
Electric Primers
(installed) 90.00
Emergency Escape Door
(quick release on
main cabin door)...... 350.00 (tentative)
Extra Generator
(selective—dual) .... 650.00 installed
Tow Bar .... 29.50 each

Optional Seating (When Available)

Plan 1. Standard 5-place arrangement plus (one) individual type chair in right side-center of cabin .... $350.00 extra
Plan 2. Standard 5-place arrangement plus (two) individual type chairs in center of cabin....$700.00 extra
Plan 3. Six individual chairs $700.00 extra
Plan 4. Five place. Includes three individual seats and one seat for two at the aft end of the cabin replacing the standard three-place seat .... $650.00 installed

Optional Paint Design and Colors
(At Extra Cost)

Painted all over to Aero Design scheme (choice of two designs) using one of color combinations listed below......$850.00 extra

Base Color	*Trim*	*Interior*
1) Academy Blue (Dark Blue)	1) White 2) Gray	Blue
2) Commander Blue (Light Blue)	1) White 2) Gray	Blue
3) Fanfare Maroon	1) White 2) Tan 3) Yellow	Brown
4) Coppertone-Brown	1) Tan 2) Yellow	Brown
5) #8 Green	1) White 2) Yellow 3) Gray	Green

Note: All prices, equipment and specifications shown are subject to change.

Flight System for ILS

(Continued from page 24)

requires change from landing configuration and a transition back to instrument flight for another try.

Semi-Automatic—Consists of a system similar to that described for the manual coupler except that a computer is inserted ahead of the cross-pointer meter. Airplane attitude and heading information as well as omnirange or localized information is fed into the computer and emerges to actuate the vertical cross-pointer needle in a manner that will provide "steering" information. Airplane position at one side of beam center will result in a needle position to indicate this condition. As long as the pilot initiates proper control movement to make good a normal approach path to the beam center, the needle will indicate "on course." By merely moving controls to maintain an "on course" indication, the pilot will be guided to and aligned with the beam center with a minimum of bracketing.

Heading reference for the semi-automatic coupler is supplied usually by a remote compass. The horizontal cross-pointer needle is actuated by the glide slope receiver as for the manual system. Various systems of this type differ in presentation of data and in operational procedures.

Basically, the procedure for final approach by use of the semi-automatic coupler is similar to that cited for the manual coupler, except that "steering" information provides a much smoother approach to the beam center and descent along the glide slope is less susceptible to instability. Also, at least one recent equipment of this type permits a large reduction in the number of instruments that the pilot must watch during this critical period.

Automatic—This system by-passes the pilot entirely and effects automatic control of the airplane in attitude and along the radio beams (including final approach to the runway) by feeding the radio signals into a computer, from which they emerge as control signals for the airplane's automatic pilot. Normal airplane attitude is maintained as a routine function of the automatic pilot and the computer output signals introduce corrections as needed for control to the beam center. The pilot monitors progress by means of a manual system or a semi-automatic system and stands by to take over and to effect a normal landing when visual contact with the runway is obtained.

Inasmuch as the primary purpose of this article is to acquaint the reader with operating features of a representative type of semi-automatic coupler and the benefits to be derived therefrom during instrument flight, we shall exclude further mention of the automatic coupler—that is a story in itself.

The basic objective of the manual and the semi-automatic coupler, then, is to enable the pilot to form an accurate mental picture of his position with respect to the runway. The more accurate this "approach visualization", the fewer the number of missed approaches. As the pilot makes the transition from instrument to contact flight, he will see what he expects to see in the proper perspective. It is apparent that an inaccurate visualization can only result in pilot confusion during the very brief but exceedingly critical transition period and will require a rather frenzied period of "flying half out the window and half on the gauges" in order to become oriented.

Aside from accuracy of approach visualization, it is highly desirable to reduce the number of instruments which the pilot must monitor during instrument flight, particularly on final approach. Admittedly, watching the several attitude instruments, watching the cross-pointer meter, and watching for the "break-through" to contact conditions places a well-nigh insurmountable burden upon the pilot.

Suppose that we arrange to present all necessary attitude, position, and steering information on two instruments. From the time of leaving the last range station until transition to contact flight, the pilot need monitor only these two instruments, with an occasional glance at the altimeter and the airspeed indicator. En route navigation by means of omniranges would be inherent. In a nutshell, this has been accomplished in the Collins Integrated Flight System—a semi-automatic type of approach coupler with many features contributing to operating efficiency.

Collins Integrated Flight System

The Collins Integrated Flight System, manufactured by the Collins Radio Company, Cedar Rapids, Iowa, consists of four new items of equipment and four auxiliary equipments. The necessary auxiliary equipments are standard on all planes equipped for instrument flight and, therefore, require only proper interconnection with the new equipment. These auxiliary equipments consist of:

Power Supply—To provide 115-volt, single-phase, 400-cycle alternating current. Power consumption is 100 volt-amps. Also, to provide direct current, 28 volts, 0.7 amps.

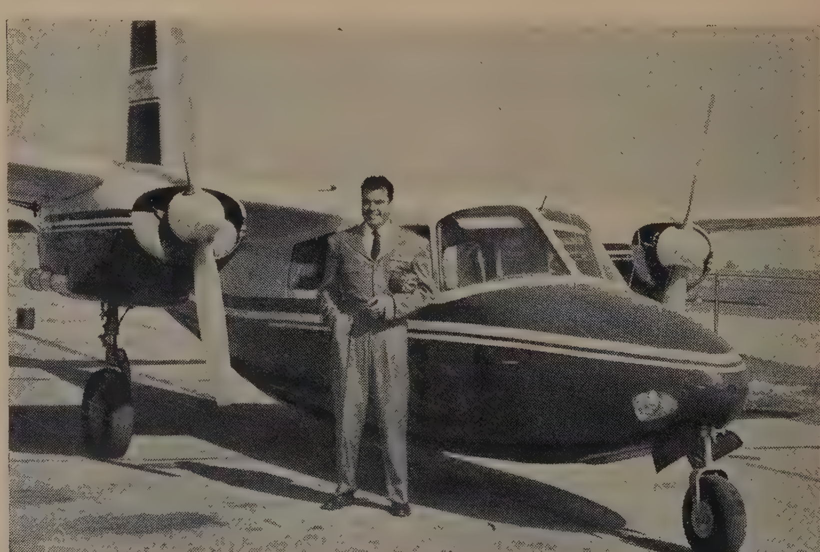
Glide Slope Receiver—Standard glide slope receiver, frequency range 329 mc to 335 mc, with associated power unit, frequency selector and antenna. Collins Type 51V1, or equivalent.

LOC/VOR Receiver—Standard navigation receiver, frequency range 108 mc to 136 mc with associated power unit, frequency selector and antenna. Collins Type 51R-3, or equivalent.

Remote Compass—Gyro-stabilized remote-indicating compass with provision for repeater indication. Eclipse-Pioneer Flux-Gate Compass, Sperry Gyrosyn Compass, or equivalent.

The four new items of equipment comprising the Collins Integrated Flight System proper are: the 331A-1 Course Indicator, the 329B-1 Approach Horizon, the 332D-2 Vertical Gyro, and the 562A-1 Steering Computer. Total weight of the system is 30.3 pounds.

Approach Horizon—The Approach Horizon is mounted on the instrument panel and requires a standard 3-inch cutout. This instrument is a roll-and-pitch reference, similar in appearance and function to a standard artificial horizon, on which is superimposed position information for precise ILS approach flying. Referring to Figure 1, the horizon bar is similar in appearance and action to a conventional horizon. Pitch information is displayed by vertical movement of the small airplane (in the center of the instrument) relative to the horizon bar. Bank information is displayed by movement in roll of the horizon bar relative to



AERO COMMANDER, *with Jack Ford (above) at controls, was flown to Japan for delivery to Asahi Newspaper Co., in Tokyo. Plane will be used as executive ship*

the small airplane.

The knob at the lower left-hand side of the instrument provides pitch indicator trim, on HDG position of the HDG-ILS switch. Adjustment of the knob applies a fixed displacement to the pitch indicator (small airplane) from center in order to compensate for minor variations in airplane level-flight attitude and in pilot sighting angle. On ILS position of the HDG-ILS switch, the pitch trim is controlled by a preset adjustment within the computer.

On this same instrument, displacement information with respect to the glide slope is displayed. The short pointer at the left-hand side of the instrument moves vertically, picturing the aircraft's position with respect to the glide slope.

On ILS approach, the vertical pointer, called the steering needle, is used only between the outer marker and the runway. This member displays steering information received via the Steering Computer, from the aircraft's localizer receiver, remote compass, and vertical gyro. Flight data from these three sources is fed into the Steering Computer which computes the required steering information instant by instant. The resultant is presented to the pilot in the form of left or right deflection of the steering pointer, telling him to execute simple turning maneuvers in order to get the aircraft on course and to keep it there. To make good the localizer course it is only necessary to maneuver the aircraft so as to keep the pointer centered. Between the outer marker and the runway, the Steering Computer automatically corrects for the affect of crosswind and eliminates this factor for the pilot to consider in making an approach.

While the steering computer feature of the system is not employed for flying a VOR course, it can be used to advantage in flying compass headings. With the right-hand knob on the Approach Horizon in the "HDG" position, steering information with respect to heading (as selected on the Course Indicator) is presented on the steering needle of the Approach Horizon. To maintain a heading it is only necessary for the pilot to maneuver the aircraft so as to keep the pointer centered.

Flag alarms from the glide slope receiver and the LOC/VOR receiver are provided in the Approach Horizon. The flag marked "G.S." is operated by the glide slope receiver while the one marked "LOC-VOR" receives signals from the localizer and omnirange receiver. Adequate radio signals for proper system operation are indicated when the flags are not in view.

Course Indicator—The Course Indicator is also mounted on the instrument panel and requires a 4¾-inch cutout. This instrument is a directional reference or compass card which has superimposed upon it a properly oriented pictorial presentation of the aircraft's heading and displacement in respect to the ILS or VOR course. The heading reference (0°–360° compass card), see Figure 2, is driven by the aircraft's remote-indicating compass and displays continuously the aircraft heading as read against the lubber line at the top center of the instrument face. For ease in flying selected headings the card is provided with a marker which may be set by means of the Heading Selector Knob. In Figure 2 a heading of 70° has been selected. The marker riding with the card shows the amount and direction of deviation from the selected heading. An output voltage proportional to this deviation is utilized from this instrument for supplying steering information, on the Approach Horizon.

The inner portion of the Course Indicator provides a graphic picture of the aircraft's heading and displacement with respect to a selected localizer or VOR course. To select a localizer or VOR course, the position indicator is rotated by means of the Course Selector knob to the desired course as indicated by the arrow pointer read against the inner circumference of the compass card. A course of 100° has been selected in Figure 2. The position indicator then rotates with the card as the aircraft heading is changed. The long solid bar is known as the course bar and represents the ILS beam center or the selected omni radial. Left-right deflection voltages from the aircraft's localizer or VOR receiver cause the course bar to move across the face of the instrument, thus showing the aircraft's displacement from the selected course. Since the bar also rotates as the aircraft's heading is changed, this bi-directional movement causes the bar to simulate exactly the selected course with respect to the aircraft. It shows both displacement of the aircraft from the selected course and direction of the course with respect to the aircraft heading. In Figure 2, the pilot holding a heading of 50° (compass card against the lubber line) sees that he is taking a cut of 50° toward his selected omnirange course of 100°. Note that the small airplane symbol in the center of the instrument face shows actual airplane position relative to the selected course. If he continues on this heading, the course bar will move downward to the right, picturing graphically his approach to the desired course.

TO and FROM indication for flying VOR courses is provided by an indicator which appears on the appropriate side of the instrument's center. If the VOR course chosen is "TO" an omnirange station, the indicator will appear on the broad arrow side of the center, as shown in Figure 2.

The presentation of the course deviation information pictorially eliminates the sensing and ambiguity problems associated with the usual type of cross-pointer indicator. When the miniature airplane is pointed toward the course bar, the aircraft is ap-

(*Continued on page 42*)

Flight System for ILS

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proaching the selected course. This is true even in localized service, regardless of whether flight is inbound or outbound on either the front or back course of the localizer.

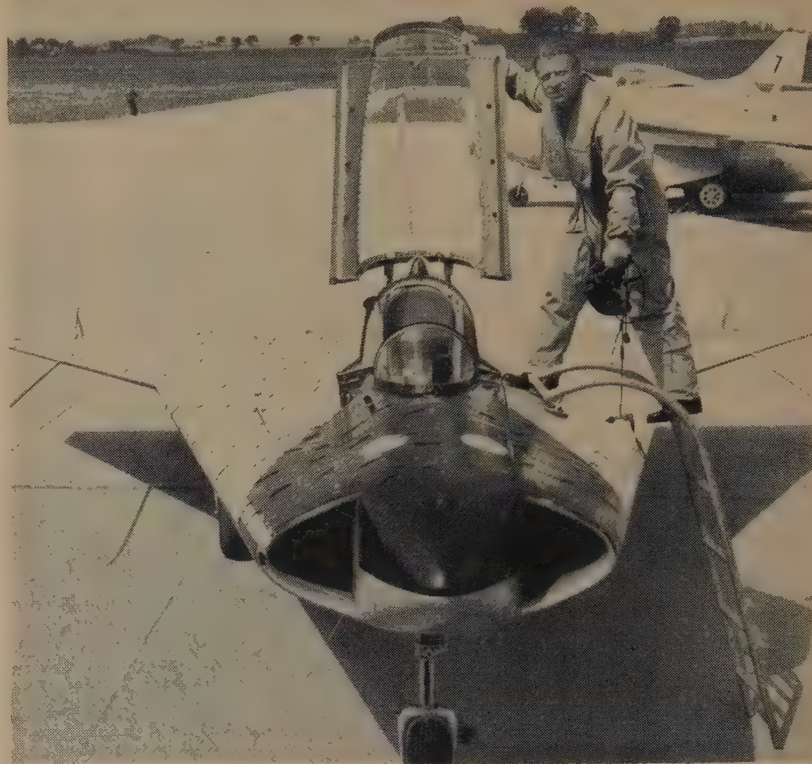
Vertical Gyro—The Vertical Gyro consists of an electrically driven gyroscope mounted in gimbals. The gyro is erected to a vertical position with the aircraft in level flight, and maintains this position to provide an attitude reference. Gyro suspension permits motion of the airplane about the roll-and-pitch axes while the gyro rotor maintains its vertical position. Signal pickoffs arranged on these axes provide voltages proportional to their respective movements. These signal voltages are routed to the Steering Computer and are utilized to operate the horizon bar and the pitch bar of the Approach Horizon. Also, these voltages are fed into the Steering Computer along with signals from the localizer receiver and airplane compass. The resultant is applied to the vertical pointer of the Approach Horizon to provide steering information.

It is desirable to mount the Vertical Gyro at a location that is level laterally and longitudinally with the aircraft in level-flight position. Normally, this unit is mounted on a shelf in the radio compartment although it may be mounted elsewhere if necessary.

Steering Computer—The Steering Computer is a collection of electronic circuits contained within a sheet-metal housing. Electrical connections are brought out to a quick-disconnect connector plug in the wall of the unit. A standard ½ ATR shock-mounted mounting rack is secured to structure at a convenient location and installation of the computer is effected by sliding the unit into the rack and tightening the extractor mechanism and two thumb screws. Electrical circuits are completed automatically by this action.

Computer adjustment controls are located in the front panel of the housing and are protected by a sheet-metal cover. These adjustments are factory preset and are used only for bench check during maintenance. Only one control, the pitch approach trim, is varied in the field. This control provides correct pitch-attitude presentation during ILS final approach.

From information relative to the aircraft's attitude, heading, and position (received from the Vertical Gyro, Course Indicator and ILS receivers respectively) the Steering Computer determines, instant by instant, steering directions for making good the selected heading or the ILS course. Signals to fly left or right are fed to the vertical pointer of the Approach Horizon while the glide slope signal is fed to its Glide Slope indicator. Also, actuated by signals received from the vertical gyro via the Steering Computer, this instrument displays pitch and roll attitude of the aircraft.



SWEDEN'S SAAB-210

Sweden's unconventional single-seat delta-wing jet research aircraft, the Saab-210, has made more than 100 successful flights since it first took to the air a year ago. Called the *Draken*, it features a wing considerably longer than the span, *i.e.* aspect ratio is extremely small. For design reasons, the wing also has a planform made up of two triangles, a "double" delta form. The Saab-210 lacks a conventional stabilizer. The wing control surfaces are combined into elevator and ailerons (elevons) which are operated by a hydraulic booster system. Other design features include a retractable tricycle landing gear. The center of gravity of the Saab-210 can be moved during flight by pumping liquid between the trim tanks in the nose and tail. A drag parachute reduces landing run, and the cockpit includes a pilot ejector seat. Tufts fastened to the Saab-210 are used to investigate the air flow over the aircraft's surfaces.

Interception of Localizer Course

The map illustrated in Figure 3 shows the use of the Collins Integrated Flight System for interception of a localizer course. Our pilot has flown "TO" the omni station and, when directly over the station, he sets in a course of 330° to intersect the outer marker. This is done by rotating the Course Selector knob until the arrow pointer reads the desired course against the inner circumference of the compass card. The radio receiver is already on the omni station frequency and so the pilot initiates a turn to bring the small airplane symbol to align with the course bar.

With the system of HDG function, the Heading Selector and the Steering Needle may be used to provide steering information to assist in maintaining the VOR course to the outer marker. Just prior to passing over the outer marker, the Course Selector should be set up to the ILS course which is the bearing of the runway (220°). The Navigation and Glide Slope Receivers are now tuned to the ILS facility. If sufficient radio signals are present both flags will disappear, the course bar will deflect ahead of the airplane symbol on the Course Indicator showing that the ILS course is ahead of the aircraft. At the point where the outer marker is observed and the course bar leaves the peg, the heading selector is moved to the outbound course, which is the tail of the course bar arrow (040°) and the steering needle is followed. The heading selection is reset as necessary to provide maintenance of the aircraft on the outbound localizer course. The sensing of the course in-

dicator is correct outbound or inbound.

After flying the specified time on the outbound leg, the heading selector is moved to the outbound leg of the procedure turn (354°). The steering needle is followed to the new heading. As the aircraft departs from the localizer beam, the course bar on the course indicator falls behind the airplane symbol. When ready to start the 180° turn back to the localizer course, the heading selector is advanced approximately 90° to an indication of 084°. Following the steering needle results in a constant rate turn since the bank limiter is controlling. This limiter prevents banks in excess of a preset value, nominally 25°. About half way through the turn the heading selector is moved to the inbound leg of the procedure turn (174°) to the localizer course. As the localizer is approached, the course bar begins to move toward the aircraft symbol on the face of the Course Indicator. At this point, the heading selector is placed on the inbound heading (220°) at the arrow head of the course bar. Using the steering needle for heading guidance and correcting as necessary to maintain the inbound localizer course, the final approach is begun. It should be noted that up to this point, the HDG position of the HDG-ILS switch has been used and that the localizer course has been maintained by reference to the course indicator.

Just prior to passing over the outer marker, the wheels and flaps may be lowered, dependent upon current procedures. The HDG-ILS switch is now placed on ILS position and the steering needle closely followed and maintained at center. The pitch trim on the Approach Horizon is now inoperative and the preset trim in the Steering Computer controls the pitch bar zero.

At the outer marker the glide slope needle on the Approach Horizon will leave the top peg and move toward center. The power is set up for proper rate of descent, dependent upon current procedure. The attitude of the aircraft in pitch is controlled so as to match the pitch bar with the glide slope needle. If this operation is maintained during the approach, the aircraft will approach and maintain the center of the glideslope beam. Power settings must be altered as necessary.

Approach to the Runway

In current systems using only displacement information from localizer and glide slope receivers, it is necessary for the pilot to execute a series of bracketing maneuvers to make good his final approach. The frequency of bracketing increases as the runway is approached and often results in over controlling to such a degree that violent maneuvers are required to reach the runway after breakout. The approach must often be abandoned when such instability is encountered.

Steering information provides damped movement of the pointer. Upon noting an off-course indication, the pilot moves the airplane controls to center the pointer. If the correction initiated thereby is adequate, the pointer will remain centered during approach to beam center and will indicate opposite error as beam center is neared so that the pilot will back off his applied correction and will thereby center the pointer and align his plane with the beam center. Inadequate correction will be indicated by off-course pointer movement, which will require additional correction to center the pointer. Steering information also dampens out roughness or short period disturbances in the ILS beam.

Midway between the outer and the middle marker a glance at the Course Indicator shows the aircraft exactly on the localizer beam center. Crosswind is corrected automatically; the drift angle appears as the difference between the ILS course and the actual heading of the aircraft on the Course Indicator. It is not necessary to change the heading selector during final approach. The bank limiter is effective during final approach and its operation is identical to that obtained on HDG position of the HDG-ILS switch.

By maneuvering the aircraft to keep the steering needle centered and by keeping the pitch bar matched to the glide slope needle, an accurate ILS approach will be effected.

During final approach, then, the pilot has full control of airplane attitude and position by watching this one instrument, with an occasional glance at altimeter and airspeed. It is assumed that the copilot is attending to preparations for landing and is monitoring engine operation.

Before or after passing the inner marker, depending upon ceiling and visibility conditions, the pilot glances ahead for first glimpse of the runway. Soon the runway end zone is sighted and the pilot makes the transition from instrument flight to visual flight and slips across the boundary to a straight-in approach right down the runway. With steering information there is no need to rear up on the beam ends trying to reach the runway —you're on the nose!

We have just completed an approach utilizing a semi-automatic approach coupler with graphic presentation and it is certainly much simpler to watch two instruments than virtually a panel full. The Steering Computer automatically corrects for the effect of crosswind and eliminates this factor for the pilot to consider in making an approach. On cross-country the pilot can fly a VOR course by means of the Course Indicator, or he can fly a compass course for off-airway operation by means of the steering needle of the Approach Horizon.

The reduction in number of instruments to watch and the graphic manner of information presentation coupled with smoothness of control permitted by provision of steering information all combine to point up the fact that the Collins Integrated Flight System is admittedly a very great improvement as regards airplane operation and pilot efficiency during approach, particularly under low weather conditions. As the operating features of this system become known, there is certain to be a place for this equipment on the instrument panels of many executive planes, that often must be flown under adverse conditions.

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(*Continued from page 19*)

the turboprop's appreciably higher idling rpm.

Concerning engine development in the future, I think everybody will agree that we may still expect important improvements in performance. These improvements may result from the following developments:

1) *Increased compression ratio.*

Compression ratio may be increased by adding more stages or by increasing the rpm. The former solution increases compressor length and weight. Increase of rpm results in high blade loadings due to centrifugal forces. The ultimate solution will be the supersonic compressor which enables high compression ratios to be reached within a few compression stages and, thus, a very important reduction of compressor weight may be obtained. It should be borne in mind that higher compression ratios mean higher compressor-outlet temperatures, and more power required to drive the compressor. Thus, increased compressed ratio only pays off if turbine temperatures are increased or if internal engine cooling is improved. Engines with higher compression ratios also will be more sensitive to ambient air temperature.

2) *Increased temperature ratio.*

An increase of temperature ratio between inlet air and gases at the turbine may be obtained by increasing the temperature limits of turbine blades (*i.e.* the use of better high-temperature alloys) or by cooling the turbine blades. Principal elements used in high-temperature alloys machining are nickel, chromemolybdenum and cobalt. The properties of titanium are, as yet, not very attractive in high-temperature alloys, but we may expect improvement in the near future. Of late, ceramic-coated parts have been introduced by Solar and Ryan, which are showing promise in increasing allowable turbine temperatures. The ceramic is sprayed on the part, thus providing a glass-smooth heat- and corrosion-resistive layer. This new method may be a great step towards performance improvement of gas turbines if the favorable experiments on test stands is proved in normal practice.

Turbine-blade cooling may be done by air tapped from the compressor or liquid fuel. Tapping the compressor may result in a loss of compressor performance (as much as 10% of the total amount of air delivered by the compressor may be needed). Cooling by liquid fuel seems more attractive; the total amount required is less due to better heat transfer and blade form is, consequently, less restricted by the internal cooling channels. The vaporized fuel might be burned in a special combustion chamber or in the exhaust pipe. Experience with either system is very limited and considerable experimental work will be needed to bring cooled turbine blades into production.

3) *Increased component efficiencies.*

Increasing efficiencies of compressors, combustion chambers and turbines is a certain way of increasing gas-turbine performance. A general review of the peak efficiencies of these components is given below:

Component	Present engines	Future engines
axial compressor	*83—85%*	*90%*
radial compressor	*77—78%*	*80%*
combustion chamber	*98%*	*99%*
turbine	*87%*	*90%*

4) *Low engine weight.*

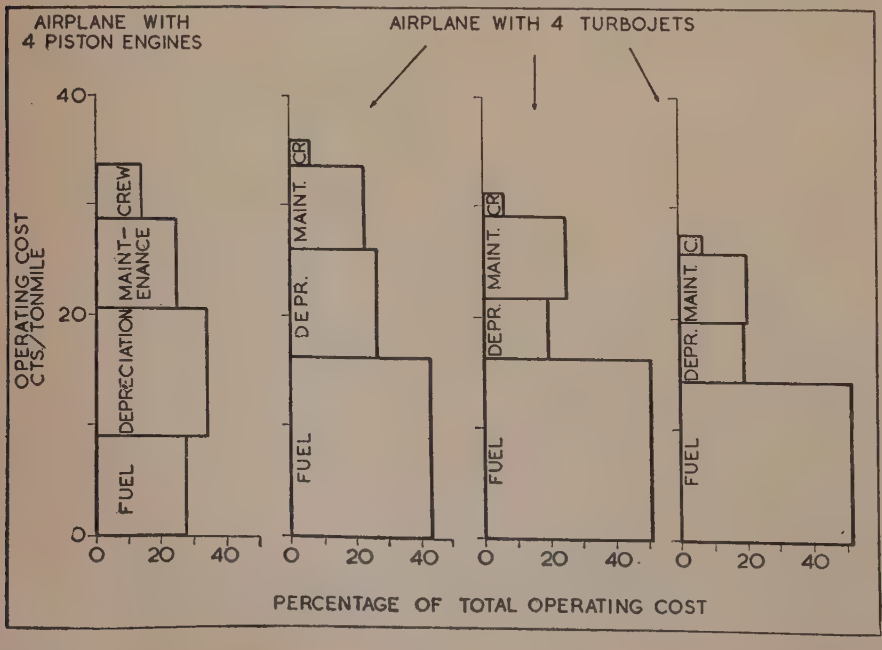
Specific engine weight seems to be reaching a minimum value and the development of engine weights after 1952-1953 is an open issue. The trend towards axial compressors, higher compression ratios, variable-area nozzles, etc., points towards an increase in the weights of components. Consequently, specific weight may remain at an approximately constant value after 1953.

For the turboprops it is less easy to draw a simple conclusion as regards the tendency of development. Only a few engines—all of them British—have reached production stage; others, having been in development for years, are still experiencing teething troubles. Consequently the general impression is that development times are still very long, mainly due to engine-control difficulties and development of suitable reduction gears between engines and props. Moreover, the first axial compressors were intended for use in turboprops and this, too, delayed development. Specific fuel consumption tends to decrease from 0.7 lbs/hp/hr for present production engines to 0.6 lbs/hp/hr for engines under development. The trend for the turbine engine of the future is definitely towards the axial compressor because of its higher maximum efficiencies, its small over-all diameter that is easy to scale up for very powerful engines, and because it is capable of attaining high compression ratios.

However, it should be remembered that for civil operation, where operational simplicity and reliability under all conditions is of at least equal importance to maximum fuel economy, the axial engine also possesses some definite disadvantages when compared with radials: the axial engine is more complex, heavier, more expensive to construct and to maintain; it has a narrow range for top efficiency and thus is less flexible and more susceptible to surging; and more problems with anti-icing and dust are possible because it is less sturdy.

If the present lead in top efficiency of the axial compressor could be slightly reduced in the future by more research in radial compressors (which, until recently, were constructed largely by empirical methods) the radio compressor may still find application in many fields.

FIG. 5—*Chart shows operating cost for jet airliner with various depreciation policies, as compared with the operating costs of a conventional reciprocating engine airliner*



Fuel

Much has already been written about the various aspects of turbine fuel. The table below summarizes some of the advantages and disadvantages of gasoline and kerosene for use in gas-turbine engines:

	Gasoline	Kerosene
Safety	*Not attractive*	*Definitely better*
Combustion heat	*110,960 BTU/gal.*	*120,060/ BTU/gal.*
Evaporation..	*Serious problems at high altitudes*	*No problem*
Availability	*Very good*	*Lower availability, but sufficient for civil-airline operation.*
Fuel cost	*Slightly higher*	*Slightly lower*

We are especially concerned about the performance dependability of the fuel. In this respect, the following factors are important: 1) vapor lock formation; 2) water and ice separation; 3) fuel freezing; 4) gum contents and stability.

1. *Vapor lock formation*

Kerosene, due to its low vapor pressure, is much better than gasoline, especially at high altitudes. With kerosene, operation at altitudes up to 55,000 ft. should not present any serious vapor lock problems.

2. *Water and Ice Separation*

Gaoline dissolves slightly more water than kerosene, and the water solubility of both decreases with temperature. Consequently, during climb and cruise, when the fuel is cooling down, free water droplets will be formed which at sub-zero fuel temperatures will turn into ice crystals. These crystals may clog the fuel filters which, for gas turbines, must be designed to filter out particles as small as 10 or 15 microns. Anti-icing additives might be used; however, normal size of the ice crystals is only from 1 to 5 microns, so clogging is not considered a very serious hazard in this case. De-icing of filters by alcohol should be considered in order to play safe.

3. *Fuel freezing*

Kerosene has a freezing point of –40°C maximum. It might be possible to lower this maximum (JP-2), but this would seriously reduce fuel availability. It will last an appreciable time before the huge amounts of fuel in the aircraft's tanks have cooled down to this temperature, even at high altitudes with ambient air temperatures as low as –60°C.

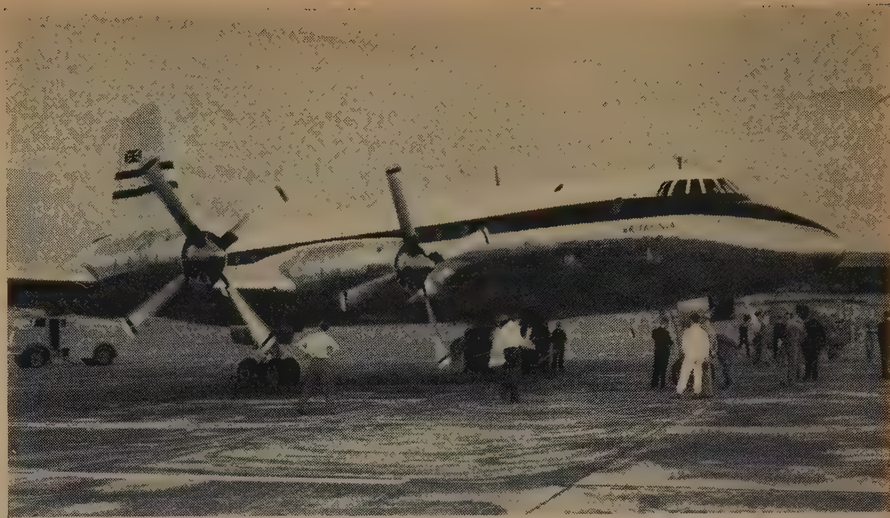
These high altitudes are definitely the realm of the very fast jet airplanes, and heating of the aircraft through ram and friction energy is appreciable. Consequently, fuel-freezing hazards exist only on very long-range flights.

When the fuel starts to freeze, certain amounts of a wax-like substance drift around, which may seriously clog filters and pumps. It should not be very difficult to develop fuel heaters for these conditions which, as mentioned above, will only be encountered after several hours of flight in the stratosphere. Bleeding part of the exhaust gases to the fuel tanks would certainly be a solution to this problem.

4. *Gum Contents and Stability*

Experience with the control of gasoline gum formation and fuel stability through the addition of suitable additives has shown that these problems can be readily solved. Therefore, we do not expect any serious difficulties to arise when using similar additives to kerosene.

From the above it is clear that a fuel such as kerosene has much to recommend it for civil-airline operation. It is, of course, not necessary to use pure kerosene; other specifications (*i.e.* JP-4) might also be satisfactory. However, it should be emphasized that a new fuel specification for civil airlines should be as close as possible to fuels already being produced by the refiners in order to evade using another "gold-plated" special aviation fuel.



BRISTOL BRITANNIA *is Great Britain's newest propjet transport. It carries 104 passengers. Twenty-five Britannias have been ordered off the drawing board by British Overseas Airways*

Operations

Having discussed the general aspects of powerplant and fuel, let us now go through the operational sequence of a flight with a turbine-engined airplane.

Engine starts

To start high-powered turbojets and turboprops the power demand on the auxiliary starting unit is much higher than that required for present piston engines. For the smaller engines (*i.e.* Rolls Royce *Dart*) battery carts may still be used, but a battery cart capable of starting the high-powered turbine would be a very bulky and unattractive unit. The new starting units often consist of pneumatic starting motors, operated by air from a ground source, by the gases from an explosive cartridge, or by air bled from an auxiliary gas turbine unit.

For turboprops, the propeller, if left in normal fine pitch, contributes a severe drag during engine starting. Therefore, turboprop propellers should be provided with a "superfine pitch;" average blade angle of attack is then practically zero and torque resistance is at a minimum.

Taxiing

Though fuel costs for jets during taxiing under the airplane's own power are high, it will probably be a more efficient procedure than a tractor-system which might easily cause confusion and delays on the taxiways.

Airplanes with turboprops will use appreciably less fuel when taxiing; a tractor system would not offer material advantages.

Attention should be paid to the possibilities of fast taxiing, which are important both for fuel economy and high block speed. In this respect the use of high-speed turn-offs from and into runways should be considered.

If tank space permits, taxi fuel for take-off is usually loaded on top of the airplane gross weight. Especially with jets, the high consumption during taxiing will require more tank space and, consequently, will decrease payload if available tank space is small.

Take-off

At the speeds and altitudes normal for present-day jet airlines, the take-off runway length required is usually longer than that of comparable piston-engined planes, due to the inherently low propulsive efficiency at low speeds of a small-diameter gas stream at high velocity. The turboprop has take-off characteristics comparable to those of the piston engine.

For future jet airplanes flying at even higher speeds and at higher altitudes, take-off characteristics may improve due to the lower weight power ratio required to obtain the en route performance.

A civil jet airplane should have a take-off length which is not a critical operational factor at a normal sea-level airport. Present jet bombers are far too critical in this respect. We favor an airplane which has a reasonable take-off length without using any power-boosting system. As the turbine engine is very sensitive to ambient air temperature (and this sensitivity increases with increasing compression ratio), we want to reserve the take-off aids for restoring power during take-off from high level and/or tropical airfields. The aids should be considered:

A. *Internal aids*

This may be done by:

1. Cooling hollow turbine blades by air from the compressor: up to 20% extra thrust.

2. Cooling hollow turbine blades by water: 20-35% extra thrust.

3. Injecting water into compressor: 25-40% extra thrust. This is a very efficient and simple system for centrifugal compressors. For axial compressors the system offers some difficulties: axial compressors operate rather close to stalling point, so that the amount of water to be injected is limited, unless the engine is especially designed to have sufficient range between design condition (dry) and stall. This, however, causes a slight loss in efficiency for dry running. And, owing to the very small clearance between blades and casing, the injected liquid must be perfectly atomized to prevent water collecting on the

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casing with subsequent damage to blades.

4. Injecting water into combustion chambers: 25% extra thrust. This system evades the difficulties cited under 3, and will not interfere with the supply of air for cabin pressure, anti-icing, etc., from the engine compressor.

5. Aferburning: extra fuel injection aft of the turbine, 30-60% extra thrust. This system is relatively simple and reliable but heavy in weight and it causes a very high fuel consumption. Apart from this, fuel consumption during cruising is also increased (up to 4%) due to the extra drag of fuel nozzles and diffusers in the tailpipe while the extremely high noise-level is a serious objection on airfields situated near built-up areas.

6. Variable nozzle area. Experiments with flaps used to obtain optimum tailpipe diameter are being conducted at present. Results are still unknown.

7. Fuel injection in front of turbine, which ignites after passing the turbine. Tests show that this is more favorable than afterburning, as it gives less increase in cruise consumption and some cooling of turbine buckets.

B. *External aids*

Among these are rockets, which may be solid or liquid-fuel types. Their advantages are no complication of the engine, and a relatively high power/weight ratio: for 5,000 lbs. additional thrust the rocket weighs approximately 900 lbs. loaded and 400 lbs. empty.

Disadvantages are limited duration of extra power, and the handling complications often imposed by the fuels used.

Due to the limited duration of thrust, rockets are suitable mainly to overcome certain critical periods during take-off. The reduction of runway length required, which is made possible by a certain amount of installed rocket thrust, is not yet clearly defined, so each case must be judged on its own merits (airplane type, airfield conditions, etc.). As the thrust of a rocket does not decrease with increasing altitude, this unit is especially suitable for high-altitude airports.

Another type of external take-off aid is the auxiliary jet engine, for instance those made by the French Turbomeca company. We have studied this development rather closely and have reached the conclusion that a very economical take-off aid might be obtained by using on this unit both water-alcohol injection and afterburner during take-off, while using the same unit (without injection and afterburning) during cruising as a compressed-air source (pressure cabin, de-icing system, etc.). The unit should be built into the plane (in the tail section, wing root, etc.) in order to reduce drag as much as possible.

Climb and cruise

Due to the higher climbing speed of jets and (to a lesser degree) turboprops, there is the danger of a turbine-engined plane overtaking a piston-engined plane, especially in clouds or at night. We do not think, however, that this introduces a serious risk. Generally, it may be said that for short ranges a turbojet-powered plane should climb to the greatest possible altitude for the least fuel consumption, even if this results in the descent following immediately on the climb. Fig. 1 (*page 18*) indicates the saving in fuel consumption and the gain in flying time of an aircraft climbing to 40,000 ft. and descending at once, over a similar aircraft climbing to 20,000 ft. and continuing at that altitude to the common destination. For this, it is necessary to design jet planes which have small cabin incidences during climb and descent for passenger comfort and to construct the pressurization system in such a way that cabin-pressure variation will be at a minimum during the optimum flights. For traffic control authorities, this optimum flight procedure is very unattractive.

Airplanes powered by turboprops, however, will consume approximately equal amounts of fuel but will show higher block-speed when cruising at a moderate altitude instead of climbing and descending. This, consequently, is a major difference between turbojet and turboprop operation on short stages.

For long ranges, optimum cruise procedure for turbine-engined aircraft is the constant true airspeed system. Consequently, the cruising altitude will increase as fuel is consumed. When traffic is not dense, this procedure may not interfere with ATC requirements, as the cruising altitude (25,000-50,000 ft.) is in regions not normally used by piston-engined airplanes. When more turbine aircraft are operating in the vicinity, ATC may require a flight plan consisting of level cruising flight with occasional steep climbs to higher altitudes (Fig. 2). This procedure offers a more severe penalty for a jet aircraft than for a turboprop aircraft, but both planes may be operated under this procedure without extravagant increases in fuel consumption.

The high altitude and speed of the turbojet airplane, and the temperature sensitivity of the powerplant pose some difficult problems for the meteorologist and, thus, for the operator's flight planning.

Accurate temperature forecasts at altitude are essential, as a 5°C temperature deviation has approximately the same effect as a 10-mph headwind. However, it seems that it will be easier to predict temperature within 5°C than it will be to forecast winds within 10 mph, due to the relatively slow changes in temperature at high altitudes.

Wind forecasts will not be very reliable in the first years to come, and a conservative fuel reserve policy is very advisable. Generally, the wind speeds at northern latitudes reach a maximum at 30,000-35,000 ft. altitude.

With jet planes it will usually be impossible to vary cruising altitude at will, due to the strong increase in fuel consumption when going lower. A headwind gradient of more than 2½ mph per 1,000 ft. of altitude is required to make a decrease in altitude result in a better fuel-per-mile figure. This means that, generally, a jet plane will have to take the high winds prevailing at its cruising altitude which, in the case of headwinds, tend to decrease the advantage of high true speeds and which will make schedules more difficult to meet. Airplanes with turboprops meet the same difficulties to a lesser degree; the break-even wind gradient will be approximately 1.8 mph per 1,000 ft.

There are cases when higher wind gradients than these will occur, *viz.* in the so-called jet streams. As, however, the jet stream usually is of limited width, it may be evaded laterally. We still know little about the cause and characteristics of jet streams, but already our present operating experience with piston-engined aircraft has indicated that, provided the jet stream itself is reasonably free of turbulence, it often enables planes to make very fast trips in easterly directions. Due to the local nature of the stream, it is easy to avoid once its location is known. At present, they are still difficult to predict; consequently the navigator has to be alert to check ground speeds frequently when flying in jet-stream regions, in order to avoid the inadvertent entering of a westerly jet stream on a west-bound flight.

Often, jet streams, especially at their boundaries, give rise to clear air turbulence. This turbulence seems to be of a more regular nature than that in clouds. Consequently, the bumps may have a quite constant frequency, as high as three per second, which might coincide with the natural frequency of a large wing. In such circumstances, the use of the orthodox "flat-topped" gust conception for design purposes is clearly unrealistic.

Present experience (BEA—British European Airways) indicates the desirability to *a*) avoid flying in areas where high thermal gradients in the horizontal are known to exist; *b*) avoid flying within 2,000 ft. of the tropopause [tropopause altitude may vary from 30,000-50,000 ft. normally; in very cold weather it may come down to 20,000 ft.]; *c*) climb or descend and/or fly at right angles to the local wind direction if meeting heavy turbulence; and *d*) alter speed as much as possible if it appears that wing oscillations are being excited by the turbulence.

BEA recommends an *increase* in speed; this may often be impossible due to the risk of striking a heavy gust, even if Mach limitation would not prevent speed increase.

The high cruising altitude requires pressure cabins with appreciably higher pressure differentials. There seems to be little doubt that pressure cabins will have to be constructed with the same degree of reliability as a wing or a control system. At the cruising altitudes of future jet transports (40,000-60,000 ft.) a pressure-cabin failure would be fatal to the occupants, even when oxygen masks are available and, neglecting the blast effect of decompression, due to the very low ambient pressure. A favorable factor is that turbine-engine compressors deliver sufficient air to maintain a considerable cabin pressure-differential even with severe leakage of the cabin; however, this increases fuel consumption and decreases range.

Instrumentation

Now let us take a quick look around in the cockpit of the jet transport. The instrument-panels of turbine-powered airplanes are usually simpler than those for piston-engined airplanes.

Engine instruments include tailpipe thermometers, tachometers, fuel-flow indicators and fuel-pressure indicators. However, especially during engine start and change of power setting, the pilot should devote a great proportion of his attention to the first two instruments to guard against overspeeding and overheating. Cockpit simplification will be emphasized in turbojet aircraft through the elimination of all propeller controls.

An increase in engine instruments in the near future is inevitable, not only because of additional devices (W/A-injection, variable nozzles) but also because the present panel does not supply all the necessary information. As important improvements we could mention an instrument to indicate jet thrust output (turboprops may use a normal torquemeter), and an instrument or warning signal for engine malfunctioning other than overspeeding or overheating. Practical experience indicates that failures of turbine buckets or combustion chambers and bearings are often unnoticed by the crew and have little influence on engine performance during the flight, but may create severe fire hazards and wreck the engine if operation continues for some time after the failure.

Flight instruments will essentially remain the same, with addition of a Machmeter for jet aircraft. An angle-of-attack indicator might also be useful for jet transports.

As far as radio is concerned, difficulties are experienced with VHF reception. VHF has a much greater range due to the increased cruising altitude, especially with turbojet-powered airplanes (Fig. 3, *page 19*). The present frequency allotment for VHF stations is based on the present cruising altitudes, with the result that in high-flying aircraft two or three VHF stations are received on the same frequency. Consequently, re-allotment of frequencies is necessary, which may cause a widening of VHF bands.

Airborne radar, which is highly desirable in order to avoid Cu-Nim formations at night, is still in early development stage.

Due to the increase in turning radius and the decrease in reaction time after visual discovery (Fig. 4), collision-warning systems become increasingly important with increases in cruising speeds. Two airplane flying at 600 mph in opposite directions reduce their separation at a rate of 1 mile every 3 seconds.

Descent

For both turboprop and turbojet, fuel consumption increases with decreasing altitude, but this is far more severe for the turbojet. Consequently, present-day descent and holding procedures are not serious obstacles for turboprop operations, but they make jet operations impracticable.

For both types, fuel may be saved by shutting down a number of engines when holding or descending at low altitudes. The practical aspects of this operation depend mainly upon the following characteristics of engines and aircraft:

1. Time to restart a stopped engine: air relighting requires no separate starting power supply, as the air flow through the engine usually keeps it windmilling at speeds well above the required minimum. At low altitude it will be necessary to slow down the airplane in order to get a safe relight. Due to the increase in idling-speed with altitude, relights at high altitude become increasingly difficult and, with present engines, it is not feasible in every-day operation to relight at altitudes over about 20,000 ft. However, experimental relights at altitudes over 40,000 ft. have been successful and, therefore, we may assume that this problem will be solved within the next few years.

2. Influence of cold and/or icing on a stopped engine.

3. Asymmetry of power if one of the operating engines fails, or during the restarting of the stopped engines.

4. Rate of climb on the operating engines, and rate of climb if one of these engines fails.

When the descent is made fast, the exterior of airplane will still be cold when the first clouds are met. Consequently, icing may oc-

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cur, especially on the underside of the wing at the location of the fuel tanks. If clouds are met around the freezing level, ice formation may result in the engine air intake and other parts in front of the compressor. Radial engines are not so much affected as axial engines, due to the higher compressor working temperature and much sturdier compressor construction of the former. Radial engines require some de-icing in the air intake, which may be solved by applying electrically heated rubber pads.

Axial engines must have efficient anti-icing means on all parts in front of the engine compressor and, preferably, on the first few rows of compressor blades. Ice formation on the blades seriously decreases compressor efficiency, and chunks of ice from the inlet may strip off a compressor blade and wreck the engine. Anti-icing for axials is best done by bleeding compressor air through ducts around the air inlet and through the inlet struts and guide vanes. Bleeding the compressor inevitably lowers the fuel economy appreciably, but this has to be accepted. Also, with axial engines it is imperative to supply heat *before* entering icing regions; once the ice starts building up, it may choke the engine within a few minutes, with a resulting sharp increase in turbine temperature (due to reduced amount of cooling air).

Because of the lean normal mixture of turbine engines, water vapor pressure has a negligible influence on engine performance. Liquid water in the atmosphere (rain, fog) has a beneficial effect on engine output due to cooling of the compression-cycle.

The ideal procedure for jet transports is to remain at cruising altitude until ATC gives landing clearance. Consequently, the decision to proceed to an alternate, as well as any amount of holding, should be done at cruising altitude. Then, the descent should be made as quickly as possible in order to save fuel: the rate of descent is usually limited by the rate of change of cabin pressure (maximum 300 ft/min for passenger comfort, which gives a descent time of 27 minutes from 8,000-ft. cabin altitude).

At present ATC is usually unable to give a landing clearance half an hour before the actual landing. To prevent excessive fuel consumption by flying at low altitude for prolonged periods, descent should be made from cruising level to the highest altitude where the cabin pressure may be made equal to or slightly lower than the pressure prevailing at the destination. At this altitude (usually about 20,000 ft.) the decision to land or to proceed to an alternate is made and holding should be done with a number of engines shut down and the remaining engines at maximum continuous power. When landing clearance is obtained, the rate of descent should be limited only by the airplane's aerodynamic characteristics (rate of descent up to 10,000 ft/min) so that the descent takes only about two minutes.

For future improvements in ATC there should be flow control in a 200-mile radius from the airfield, radar monitoring over the same area, and use of a precision navigation system to form narrow airlanes for each approaching plane.

Landing

The landing of airplanes with turboprops is not very different from that of piston-engined airplanes. Some caution should be exercised in the matter of overshoot as the turbine engine takes slightly longer time to accelerate to maximum power. Propellers may be made reversible but experience with the Vickers *Viscount* indicates that a strong deceleration effect may be obtained using windmilling propellers with a very fine pitch setting after touchdown.

For jet aircraft, the landing is far more critical because there are no windmilling propellers and the jet plane's very smooth aerodynamic finish produces little drag; and because of the idling thrust of jet engines (120 lbs. per 5,000 lbs. take-off thrust). Consequently, the following landing aids should be incorporated:

1. Aerodynamic brakes, which may be drag flaps (also used for the control of rate of descent and speeds when in flight) or special accessories. A parachute, to be released on landing, would fit this "special accessories" category. Packing of ribbon-type parachutes is not critical, consequently the parachute could be wound back in (by a winch incorporated in the airplane) during the last stage of the landing roll, and only the little guide-parachute would have to be repacked on the apron. Still, the extra-weight, extra work and complication are not attractive for airline use.
2. Landing flaps producing a high maximum lift coefficient in order to decrease touchdown speeds.
3. Very reliable wheel brakes incorporating non-slip devices (*e.g.* Decelostat).
4. Jet engines for use in civil transports should be capable of accelerating to maximum thrust in a short time (*i.e.* 5 seconds) in order to enable overshoots to be made safely.
5. In France experiments are being conducted on a new air brake: injecting a high-velocity airstream into the center of the exhaust jet in opposite directions, in order to spread the jet into an "invisible parachute". So far we have not received data on the practical results of these tests.

JET QUALIFICATION *exercises aboard the aircraft carrier U.S.S. Kearsarge, off the coast of California, were witnessed recently by a group of members of the Institute of Aeronautical Sciences. The men are (left to right) Lt. Gen. Earle E. Partridge, USAF; Grover Loening, Consultant, NACA; Rear Adm. D. S. Cornwall, USN; Wellwood Beal, Boeing Airplane Co.; Lt. Gen. James Doolittle, USAFR; Dr. Hugh Dryden, Director, NACA; and Bennett H. Horchler, assist. pub. of Skyways*

Even with these aids, however, landing on slippery runways is not without hazards. Tests have been made with jet nozzle flaps reversing the direction of flow of the gases, but so far with little success. Another possibility is the use of reverse JATO, but this could easily cause grit and dust to enter the engine, and it would probably seriously limit the pilot's visibility. The ultimate solution will involve reverse thrust from the jet engine and effective easy-to-handle air brakes.

Maintenance and Testing

Much has been said about the "lack of vi-

bration" in turbine-powered aircraft. This is true, as far as passenger comfort is concerned, because the high-frequency buzz of turbine engines is probably less uncomfortable to the human body than the low-frequency vibration of piston engines. Whether it has any beneficial effect on maintenance cost remains to be seen. I can imagine that a radio tube will show failures on a piston-engined aircraft through fatigue of the filament, while the same tube may fail on a turbine-powered plane because of fatigue on the less flexible anode. Consequently, I don't expect too much improvement in failures caused by vibration fatigue, but I hope practice will prove me to be wrong.

These are three main components of overhaul:

1. *Airframe*

Construction of the airframe will probably be only slightly different from present-day construction: new materials, like titanium, may be used and the skin gauges will be heavier in order to withstand higher pressurization and aerodynamic loads and to preserve smooth wing surfaces under all flight conditions. The thicker skins will not easily be damaged, but repair of damaged sections will be costly, both in material and manhours, and will call for higher accuracy. With jets the lower landing gear will facilitate maintenance appreciably.

Generally we expect that aircraft with turboprops will have approximately equal structural maintenance cost as piston-engined aircraft, while these costs will be slightly lower for jet aircraft.

2. *Engines and Propellers*

Civil operation will require at least 500 hours between overhaul, and even on this basis turbine-engine maintenance cost per flying hour is about 50% more than the cost of comparable piston engines. Generally, overhaul cost of axial engines will be higher than those for centrifugal engines. This is because *a*) slight damage (pitching, scratching) of axial compressor blades cannot be repaired easily; damaged blades must be replaced. Comparable damage on radials may be repaired by filing with negligible effect on efficiency; *b*) balancing equipment and measuring equipment to check blade settings is more expensive for axials; and *c*) replacing a damaged axial compressor costs about three times as much as replacing a centrifugal one.

However, it should be borne in mind that the turbine engine is still very much in its development stage, and since the first turbines became operational, about seven years ago, an enormous decrease in overhaul cost has been attained. It is reasonable to suppose that this trend to decrease will continue for the first years to come. Thus, the general opinion is that with increasing overhaul periods and increasing experience, the overhaul costs of turbine engines will ultimately be equal to or even lower than those of comparable piston engines. Even with equal maintenance cost per hour the cost per ton mile should be lower, due to the increased ton-mile production.

There is a marked difference in the structure of the overhaul cost of turbine and piston engines. Material cost for turbines is relatively great (due to many parts which must be replaced) and labor cost is relatively low (due to simplicity of installation and few moving parts with their associated accurate fitting tolerances).

When testing turbine engines, and especially turbojets, the noise level is extremely high (150 db). Consequently, noise mufflers (both for intake and exhaust) are mandatory not only to keep the airport quiet but also to protect people living in the vicinity.

Propeller maintenance cost for the turboprop will be higher than for piston engines due to the more complicated propeller. The thin-section propeller blades will not stand much repair (scratching due to stones, etc.) and consequently a higher proportion of damage blades will have to be scrapped. This effect may be partly mitigated by the favorable influence of reduced vibration.

3. *Instruments, Radio and Systems*

Overhaul cost of these items will be reduced appreciably due to the simplification of pressurization and de-icing systems, and the reduction in the number of instruments.

Boost control systems and flush antenna may cause a slight increase in maintenance cost, but the balance will certainly be in favor of turbine aircraft.

Safety

For the safety of passangers and crew, the use of kerosene in gas-turbine aircraft is a valuable asset. There are, however, some new aspects in turbine-powered aircraft construction and operation which should not be overlooked.

The pressure cabin should be constructed with the same safety and reliability as a major structural component (*e.g.* wing). The main cabin structure (chairs, belts, floor) should be able to resist higher deceleration loads in forward direction than the 6 G required for present-day airplanes. For safety, load factors of 15 to 20 G's might be desirable, if they can be incorporated without excessive weight penalty; 9 G's is a minimum for future transports. Backward-facing seat might increase passenger survival in high-deceleration crashes. Attention should be paid to emergency exit installations.

The engine nacelles should incorporate sufficient isolation from the wing structure to prevent serious wing damage if combustion chamber or tailpipe failure occurs. It may be necessary to take special measures to prevent serious airframe damage through failure of a turbine wheel, though the kinetic energy of turbine discs is so great that it is difficult to visualize a solution. Failure of turbine buckets is, as has been shown in practice, not a serious problem as they will usually be carried away by the exhaust gases.

Air traffic control procedures should be revised in order to accommodate high-speed high-altitude planes. This point may be summarized as:

1. High-altitude (20,000 ft.) holding stacks.
2. Radar monitoring by airport control.
3. The time for recognizing obstacles or other airplanes decreases rapidly and high accelerations in turns occur with increasing cruising speeds. This is an argument in favor of using time as the basis for VFR and IFR, as under the present limits a 500-mph airplane has only about 21 seconds visibility for VFR on-airway (3 miles), and only 7 seconds for non-airway VFR limit (1 mile).

With higher speeds navigation has to be accelerated; the use of radio systems with an uninterrupted constant and clear presentation of the airplane's actual position is necessary in order to avoid big navigation errors by crossing an unforecast jet stream, for instance.

Operating Economy

For airline operation the operating economy is, of course, one of the most important factors. And it is here that the turbojet-powered aircraft offers some special aspects, which, I feel, will be of general interest.

In the past, aircraft became obsolete within a relatively short time, *i.e.* as soon as new transport designs offered the possibility of a marked reduction of block time. Generally, this has been after about five years. Technically, the obsolete planes (DC-3, DC-4) were still in perfect condition and many have been used as corporate aircraft for many years after their replacement by faster planes on the passenger-carrying trunk lines.

The faster the airplane, the longer will be its operational life. At higher speeds, increment in block speeds becomes progressively smaller for equal increments in cruising speed. Achievement of an increase in cruising speeds becomes more difficult when cruising speeds are higher due to the drag increasing with the square of the velocity, and due to compressibility effects.

The introduction of the powerful turbojet not only enabled the aircraft designers to increase the cruising speed to almost twice its present value, *i.e.* 500-600 mph, but also *required* this increase in order to achieve reasonable fuel economy with jet aircraft. Lower cruising speeds inevitably cause lower fuel economy. Higher cruising speeds are unlikely with the present aircraft because the fuel consumption per mile cannot be lowered due to the increasing drag at higher speeds; and the disturbing effects of compressibility make operations over critical Mach numbers improbable.

The only possibility to increase cruising speeds appreciably is to start operating in supersonic realms; this, however, will definitely require revolutionary changes in airplane configuration, structure, and powerplants. A speed of 900 mph may be considered a minimum for undisturbed supersonic operation; the problems associated with passenger-traffic at these speeds are so enormous that this may be considered impossible for the next 10 or 15 years.

Consequently, the economic obsolescence of a 550- to 600-mph transport aircraft may last as long as 10 or 15 years, or about twice the present depreciation period. Technically,

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Airline Turbines

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an airframe of good design will be able to stay in perfect operational condition for this same period, provided the maintenance is up to modern standards.

At the present rate of gas-turbine development, however, it may be expected that engine characteristics (specific consumption, overhaul periods) will improve materially within five years. As fuel costs form an important part of total operating costs for gas-turbine aircraft, it will probably be worthwhile to replace the engines of existing turbine aircraft with new engines of about the same output after five years. This will reduce maintenance and fuel costs appreciably. The design of turbine aircraft should be such as to enable the operator to replace the engines with a minimum of changes to the airplane; this is an important argument in favor of good installations.

The operating costs of comparable turbojet and piston-engined passenger aircraft under the following conditions for the turbojet-plane are shown in Fig. 5.

A. Present jet engines, depreciation of aircraft and engines over 5 years.

B. Present jet engines, 5 years engine depreciation, 10 years aircraft depreciation.

C. Future jet engines with 10% less fuel consumption and hours between overhaul increased from 500 to 700; 5 years engine depreciation, 10 years aircraft depreciation.

The piston-engined plane is depreciated (aircraft + engines) over 5 years.

Capital Investment

Due to the increased block speeds, the number of turbine airplanes needed to fly a certain route pattern will be less than the number of piston-engined planes flying the same routes. Thus, less capital investment would be required for equal ton-mile production, if purchasing prices of comparable jet and piston-engined aircraft are assumed equal. This would be an important advantage of fast aircraft. To my surprise, I found that the tentative purchasing prices for at least two recent designs for jet transports are so high that it would, in effect, be *more* expensive to buy 10 jet transports than 20 piston-engined aircraft. The reason for this excessive price has not come to my knowledge. However, I want to point out that, if these prices stay at that level mentioned the economy of a jet transport will be severely curtailed.

It is my opinion that the price difference between jet and piston-engined transport aircraft of equal payload capacities should be approximately equal, the higher finish and structural requirements being balanced by the simplifications resulting from the powerplants. Ultimately, the jet transport would still be slightly more expensive because the number of spare parts needed for a fleet of turbine-powered aircraft will be a larger proportion of the total capital investment, mainly because of increased number of spare engines and—for turboprops—more reserve propellers, which will be needed in order to have the plane leave the shop as soon as possible.

Personnel

As I mentioned earlier, we will have to adopt our way of thinking to the new powerplant, "we" meaning everybody throughout the airline organization, from the director down to the office-boy. Sometimes, this may be difficult, as we are so accustomed to our old habits, and certainly all our present ideas cannot be changed in just one day. Here is just a rough outline of those changes.

1. *Aircrews and Operation Ground Staff*

Aicraft with high cruising speeds will appreciably reduce block times and thus crew costs per mile, even if the number of crew members is kept at present levels. Due to the simpler engine handling systems and the flight duration, flight-engineers will be less valuable after the airplane has passed its breaking-in period. This, of course, applies more to the jet aircraft than to turboprop planes. The reduction of flight time and the development of position-indicating navigation systems will also tend to eliminate the radio-operator on short and medium-range flights, so that, ultimately, we foresee a crew of two pilots, with exclusively R/T communication for traffic. For long-range flights (trans-oceanic) both flight-engineer and radio-operator may be retained. However, with jets the time for crossing the ocean may be reduced to about six hours, so that no reserve crew members need to be carried.

Turbine-powered aircraft operation, especially with turbojets, calls for quick decisions on the part of the crew. For instance, the decision to land or to proceed to alternate should preferably be made at cruising altitude or, in any case, before descending below 20,000 ft. In order to enable the crew to make this decision, the operations ground staff has to furnish the crew with all pertinent data on weather, visibility, alternates available, etc. Consequently, the ground staff must have a very thorough knowledge of piloting and, preferably, should partly consist of active or retired pilots. We may, therefore, conclude that turbine-powered aircraft will cause an appreciable reduction in crew costs, but more and better qualified men should be used to monitor the flight from the ground.

The training of pilots on the new aircraft will have to be cut down to a minimum of special training flights, as turbine-powered aircraft will generally be more expensive to operate per hour and it will be extremely expensive at low level (landings and overshoots) due to the high fuel consumption, especially with turbojets. Consequently, training of pilots should be done mainly on normal operating flights, when they are aboard in their function of 2nd (or 3rd) pilot, preceded and supplemented by a thorough ground course in flight-simulating electronic trainers.

2. *Ground personnel*

The introduction of turbine-powered aircraft will, of course, have a direct effect on all branches of the technical department, as, for example, the engine department, test benches, overhaul shop, line maintenance, instrument shop, etc. These effects have already been mentioned. However, the indirect effect will perhaps be just as important. In order to obtain the highest utilization of fast airplanes the stop-over and turn-around times *must* be cut down. If, on a certain route, the block speed is doubled by the introduction of turbojets, the stop-over times should be halved in order to obtain the same aircraft utilization. In this respect attention should be paid to simplifying load sheets, using an average empty weight for all planes of one type, and efficient loading and unloading. Fueling should be done at one point, preferably under the wing, at the highest possible rate of transfer.

Our studies have shown us the importance of effectively scheduling jet transport operations on routes through tropical areas. On the critical stages take-off should be scheduled early in the morning or late in the afternoon in order to minimize payload restrictions caused by the increased temperature accountability of the jet-airliner. Attention should be paid to the speed of ground communication along the routes. The present telex, telegraph or telephone often leave much to be desired in the way of speed and introduces risks of reproducing-errors. Ultimately, we would like to see a combination of television and telex: any documents (passenger lists, load-sheets, weather maps, position reports, etc.) placed in the transmitter should be automatically reproduced in full at the receiver within seconds.

Generally, we may conclude that turbine-operation requires an effective streamlining of all ground operations and a training of personnel to make them "time conscious" in order to reduce ground time to the minimum.

As stated at the beginning of this paper, the turbine-engine is the next step forward in the development of civil air transportation. Much will take place in the next few years, and our thinking must be ready.

This paper by Edw. A. Driessen was presented at the SAE National Aeronautic Meeting, Hotel Statler, New York. It is printed here through courtesy of Mr. Driessen and The Society of Automotive Engineers, Inc.—Ed.

The Aircraft Industries Association has come up with an interesting comparison: The landing gear alone on a modern Navy carrier plane weights more than an entire Navy fighter plane of the 1930's!

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C. R. Davenport (*EAL Engr. Rep., Lockheed*): "Without a doubt, first cost does have a definite bearing on the desirability of a jet transport. As Mr. Froesch pointed out, if the airplane is going to cost 2½ million dollars, we'd have to be certain we were getting a revenue-producing airplane. Operating costs also are a definite factor."

Leslie Neville: "*I would think that the operating cost would be the more important over the long pull. But there still is a question in my mind as to whether we are really ready for jet transport in this country. What do you say, Mr. Hage?*

Bob Hage (*Project Engr., Boeing*): "As far as costs of jet transportation are concerned, it seems to me we should consider them from the standpoint of the airline operator. For an airline, as in any business, the percentage return on investment is the main financial criterion. The percentage return on investment is really a ratio of the profit divided by the investment, and the profit can be further divided into income minus total operating cost. On the basis of theoretical calculations from the standpoint of direct operating cost, the turbojet is more costly than the turboprop, and the turboprop is somewhat more costly than the turbo-compound or the compound-engine transport, each selected at optimum range. However, I think we should keep in mind the other economic factors. The indirect operating cost may be much the same on all three, and that tends to level out the differences on direct operating cost. Since the jet operates faster than the turbo-prop and the compound type, assuming a given utilization per day, a fewer number of pure jet airplanes can accomplish the same amount of business in a given time period. It would, therefore, seem to me that the investment in the faster flying fleet is less than that of the slower flying fleet. When these factors are considered, the percentage return on investment appears to come out about the same for all the types discussed here today. That being the case, the issue perhaps should be decided upon factors other than what it costs the passengers to ride. If it costs the passenger the same amount to ride, then the case for the pure jet should be decided on relative reliability features of the operation. I think a discussion of these factors may be important.

Leslie Neville: "*You're quite right, Bob. And there is still another factor due consideration, namely, the changes in the airway pattern. There were profound affects on the pattern throughout the country when we went up to today's 300-mph operating speeds. Problems in meteorology developed and there will be more as we get into even higher speed brackets, higher altitudes and the jet regime. Mr. Aldrich, what are your thoughts on the meteorological aspects of turboprop and turbojet operations?*

J. H. Aldrich (*Chief Aviation Forecaster, USWB*): "The Weather Bureau is investigating the problems that we can anticipate in jet operations. Mr. A. C. Campbell Orde of BOAC talked to a number of our Weather Bureau men on that very thing a few months ago. We're gaining actual experience today in studying the jet stream, the high-level winds, etc. The Weather Bureau-Air Force-Navy Combined Analysis Center in Washington is forecasting high-level winds twice daily as a regular thing. This information is beng distributed by facsimile to the forecast centers and also to the airlines. At present this is only being done for the continental U.S., because there is a problem of getting adequate observations over the oceans. Adequate reports over the ocean would, of course, involve a great deal of expense.

"I would like to suggest that we not overlook, both in current and prospective jet operations, the need for direct pilot-to-meteorologist contact rather than accepting a written forecast on a form. Today, for example (July 16, 1952), a man could fly the jet stream from here (Los Angeles) to Chicago, if he went via Amarillo, and have an average tailwind component of 60 to 70 knots at 40,000 feet. But if he went via Las Vegas and Denver, he'd have a headwind half the way. If a man were flying from San Diego to Great Falls at jet aircraft altitudes, he'd have to cross two jet streams and he would experience four of five different changes in wind. That would involve a considerable problem. There will be other problems, too: turbulence, lightning, icing, etc.

"I think the big problem, however, will be to get increased reports over the ocean so that we can make accurate forecasts. There is a decided advantage in flying the jet stream and there is also a turbulence factor to be considered in getting into and out of the jet stream

We need to know more about that turbulence factor."

Leslie Neville: "*Do you mean that we might have to change the airline map in order to fly more efficiently with jet transports? Will we have to fly different routes than we fly now?*"

John Aldrich: "As I understand it, the operation of turbojets will be for long-range flights and there should be quite a bit of flexibility as to course. If riding a jet stream takes you too far off course, it's of no value. And there is still that problem of turbulence in getting in and out of the jet stream. The evasive action presently used for the turbulence that exists alongside the jet stream is to change altitude instead of changing course.

"One point I want to make is the necessity of a pilot actually seeing the charts. If a pilot can see the charts and talk them over with a meteorologist, he can be helped. The pilot will then understand his problem and know what to do about it when he is in the air. But if he has to rely solely on a prototype forecast stated in words on a form, he won't get the entire picture. We cannot present the complete picture to him that way."

Leslie Neville: "*In other words, it will re-*

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quire a change in operating procedures?"

John Aldrich: "In some respects, yes. This might be contrary to conceptions in some circles but I believe it is a case for airlines having their own meteorologists as consultants working with the dispatcher and the pilot. Obviously, every airline pilot can't walk to a Weather Bureau forecast office on a large terminal field."

Leslie Neville: *"What about some of the other operating problems? For example, stacking over Washington or over New York? Isn't that a limiting factor as far as continental jet operations are concerned?"*

C. R. Davenport: "Until such a time as the fuel consumption problem is licked, I think air traffic control will have to be adjusted so that holding won't be necessary."

Leslie Neville: *"You mean that jet planes would have to have priority over others?"*

C. R. Davenport: "Yes."

Frank Fink *(Chief Engr., Convair):* "I think those are points that come into the economic picture of jet transport operations. For example, the effect varying weather has on the fuel consumption of a jet transport. If you take fuel consumption at the different altitudes and relate that consumption to headwinds, you'll find that it would take the same amount of fuel as a 6-mph headwind for about 1,000 feet altitude. If, because of weather conditions, you flew at 10,000 feet instead of 40,000 feet, from the fuel consumption angle you'd be flying fuel-wise the same as you'd be with a 175-mph headwind. The same thing holds true for temperature. The fuel consumption per 5° Centigrade temperature rise is equivalent to about a 10-mph headwind.

"As far as stacking is concerned, if you come over your destination at 30,000 feet, it would take 20 to 30 minutes to get the airplane down on the ground, even if you have dive brakes and other aids, without ever exceeding the design speed of your airplane. This let-down time might use as much as 600 gallons of gas. Economically speaking, those factors are serious ones."

Leslie Neville: *"Charlie Froesch mentions the design problem of taxiing a jet transport. He talks about having an auxiliary powerplant for jet transport taxi purposes."*

Frank Fink: "That's another thing. You'd use a lot of gas taxiing out to the end of the runway and then waiting there your normal holding time for a release from the tower and your check out. I don't know what the fuel consumption would amount to, but I think there is going to have to be a method devised for towing a jet transport out to the runway and waiting for a clearance before any engines are started. I'm talking here about turbojet not turboprop. Turboprop is much more efficient than that."

Leslie Neville: *"Mr. McBrien, what does United Air Lines think about the economics of operating jets?"*

R. L. McBrien: "In addition to the problem of stacking, we feel that the time when the decision to divert to an alternate is made is very critical. The difference in fuel required, depending on the policy adopted in regard to an alternate, can be very sizeable. If the decision is made to divert to an alternate when you still are at cruising or a reasonably high altitude, the fuel required would be quite a bit less than if you were to descend to the destination and then have to climb out to 20,000 feet again and divert to the alternate. That descent and climb-out requirement, we feel, must be included in determining the amount of fuel reserve to be carried. It does add greatly to the fuel that must be put into the tanks at the time of dispatch. The policy that is adopted on diverting to an alternate airport will greatly affect the economics of any given flight."

Leslie Neville: *"Could you very roughly estimate the additional reserve required as compared with that required when diversion is made from cruising altitude without descending to and climbing out from the destination airport?"*

R. L. McBrien: "Well, I'll have to give you just a very rough estimate on that. We have made some approximations in considering that problem, and the figures go something like this: if a trip were planned to terminate at San Francisco with an alternate at Bakersfield, which is about 260 miles from San Francisco, the added fuel required to descend to San Francisco, refuse landing, climb back up to altitude and divert to Bakersfield as compared to making the decision to divert while at cruising altitude and then just going directly to Bakersfield, would weigh approximately three tons. That is for an airplane capable of the range of Chicago to San Francisco non-stop . . . and at the speeds we're talking of, in excess of 500 mph."

Leslie Neville: *"At this stage, is that worth the difference from the standpoint of practical economics?"*

R. L. McBrien: "Certainly that is one of the problems that must be investigated thoroughly in terms of the demand for that type of service and the developments that occur concurrently."

Leslie Neville: *How about Pan American? Mr. del Valle, perhaps you have different problems. You've got to compete with the* Comet *someday."*

Wm. A. del Valle *(Resident Engr., PAA):* "That is our big problem today. We think that it won't be long before the British will have *Comets* competing with us on the New York-Bermuda run and the New York-Nassau run. Frankly, we don't like it."

Leslie Neville: *"How much quicker can you get to Nassau from New York or from New York to Bermuda in the* Comet *than you can now with your present equipment?"*

Wm. del Valle: "That I don't know."

Leslie Neville: *"Could you make it more comfortable for the passengers while they are in the air so that they wouldn't be in such a hurry to get there?"*

Wm. del Valle: "Yes, but I still think there would be a certain amount of attraction for the people to say that they were flying in a jet airplane."

Leslie Neville: *"Let's get into the cold hard facts of economics and who's paying for it."*

Wm. del Valle: 'The big desire with Pan American Airways today is to arouse some interest in this country to build a jet transport that will be available about the same time the *Comet 3* and the *Comet 4* are placed in service."

Bob Hage: "I'd like to add a comment regarding this comfort business that was just brought up. It seems to me that in comparing a jet with any of the existing types of American air transports the cabin seating and other interior features are much the same. Comfort probably should be compared on the basis of noise level and vibration and, most of all, on how long the passenger will have to sit in the seat. I think an irrefutable argument is that the sooner you get to where you're going, the more comfortable you're going to be. Right there I think the pure jet transport has a considerable advantage over any propeller-driven transport."

Leslie Neville: *"You are absolutely right, Mr. Hage. We are never satisfied. I came here on an overnight trip . . . and I felt that was too long. Mr. Dickinson, how does*

STACKING *problem was called "serious one," by Frank Fink (below, left) of Convair. Seated at Mr. Fink's left are Kenneth C. Gordon of Boeing and William del Valle of Pan American*

Douglas feel about the whole problem of economics and the likelihood of a solution, design-wise?"

W. T. Dickinson *(Exec. Engr., Douglas):* "We feel, or I should say 'I feel' because there is no such thing as a composite point of view in a particular company, that there will be problems that an operating airline will have to face with respect to the passenger load factor when they are faced with competition from a jet transport. On the route from New York to Bermuda which you mentioned a minute ago, it appears to me that there will be about an hour's saving with the *Comet*. In that estimate I have assumed a 400-mph block speed, which I am sure they can make good while cruising at 490 mph, and the distance is 750 miles. It works out to about an hour's saving. Therefore, the question before Pan American and before any other operator is, if the airplane is put on the route between New York and Bermuda and it makes the trip in one hour less time than the airplanes you have in your own stable, then obviously the plane that flies the faster is going to get the higher load factor *if* the price is the same. The question that Pan American has to answer is, what is the relative worth of speed versus cost? This is the thing that has caused so much trouble in the thinking of many people. In my opinion I don't know of a single place where there has been an honest, straight-forward test to determine the difference between cost and speed, that is, the price the public will pay for speed.

"In every case where the public has been given a lower price on a route between any two points, they have also been given different types of accommodations. So, what you really need to know to solve this riddle—the riddle that Pan American Airways is going to find themselves in if they do not have a jet transport to compete with another competitor—is: how much less do they need to charge for their tickets to maintain their load factor at the same value that the other fellow is going to push his load factor to if he goes faster? This is a problem for which at the moment there is no solution. The ticket costs in the United States are not under the free enterprise system, as far as I know. All the airlines charge the same rates. There is no place where you can get together and say 'I charge ½¢ less per mile and I go 25 mph slower than you do and my load factor is the same as yours.' There have always been other factors that have muddied the waters in getting an honest answer to this problem. The International Air Transport Association fixes it so that all prices across the Atlantic are the same. In that way the airlines can only compete in the comfort of one airplane against another. Therefore, I say that I don't think there is any answer to that particular problem. The economics of the jet transport are all wound up with how much the public is willing to pay for increased speed. If they get the increased speed for the same price, obviously they are going to get in the airplane. But, if

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the guy charges them what it actually costs to fly it, I'm not so sure."

Leslie Neville: *"Let's turn for a moment to the problem of pressurization and decompression."*

J. H. Aldrich: "I'd like to ask about the certainty of the pressure seal. Since the outside air pressure at 40,000 feet is only about one-fifth of that at sea level, a failure of pressure seal would be rough on the passengers."

W. T. Dickinson: "That is a problem, indeed. When you pressurize an airplane to 11 to 12 pounds per square inch, you have yourself quite a task. However, we expect that with inward-opening doors and inward-opening windows, we will not be depending on the seal alone for our safety. In other words, a rubber seal could fall out and all you would lose would be air—air that would escape at a higher rate than you had originally designed the airplane for, but that would not necessarily mean that you would lose your pressure. You are pumping air in at a rate of 100 pounds a minute or more for, say, 80 passengers. Therefore, 100 pounds per minute is going out. If you should break a seal on a window or door, this would mean that maybe 80 pounds per minute would go out your regular valve and 20 pounds per minute would go out the broken seal.

"I won't say that there are no problems in building a pressurized transport for operations at high altitude, but I would hesitate to say that those problems are insurmountable. We can do it, but it won't be without some troubles."

C. R. Davenport: "I think that double cabin windows would be an absolute necessity."

W. T. Dickinson: "We have every expectation of using double windows. However, you can't use double doors. We expect to use inward-opening doors and in that way sidestep the problem of a blown-out door."

R. L. McBrien: "It is absolutely necessary that the structural integrity of all openings that could greatly reduce cabin pressure in event of failures should equal that of the wing."

Leslie Neville: *"Hall, have you any thoughts on that phase of the design of jet transports?"*

Hall Hibbard: "No, I can't add any more than what Dickinson already has said, namely, that we know that it's a design problem, but we feel that it's one of the lesser design problems connected with the jet transport. We think that too many people worry about that and we feel that it's one of the things that certainly can be designed into the airplane and will be. I don't look for any trouble in that regard whatsoever."

Wm. del Valle: "The problem of oxygen for the passengers is going to be quite complicated. Are you going to have the passengers wear masks when you are cruising at 40,000 feet or are you going to instruct them in how to put on the masks in the event of explosive decompression or leaking? And how much oxygen are you going to carry? Are you going to carry enough oxygen to bring the airplane down to 10,000 feet . . . and if so, how about fuel requirements for continuing the flight at low altitude? All those are problems that have to be solved."

K. C. Gordon *(Chief Sales Engr., Boeing):* "In general, our philosophy has been the same as that expressed by Mr. Dickinson. You design the airplane so that you will not have an explosive decompression, and your sources of pressure are such that it would take a door or an opening of similar size to cause explosive decompression. Loss of a complete window, we think, could be handled. In addition to dual windows, which we regarded as a necessity, we think the jet transport should be equipped with dive brakes to permit a high rate of descent in the event of such an emergency. At the moment we consider it impractical to have oxygen for all the passengers as an emergency feature. Of course, oxygen probably would be carried to take care of ill passengers. We believe, too, that the crew should have oxygen available and that at least one of the crewmen wear an oxygen mask or have a mask readily available at all times. We don't think that in the event of a decompression that required oxygen that you could actually instruct 80 passengers and save them by that means. You shouldn't have a decompression in the first place, but if you do, the airplane should be able to get down to a survivable altitude in a very short time."

Leslie Neville: *"From a purely psychological standpoint, the idea of trying to train passengers to wear oxygen masks is a tough one to face. What do you think about it, Mr. Davenport?"*

C. R. Davenport: "The first consideration should be in the design of the airplane so that it won't fail. I think that providing oxygen for the crew and 10% of the passengers should be sufficient."

Frank Fink: "I don't think designing for those features in an airplane is any worse than a lot of other things you have to do. On the other hand, every time we put more gadgets, more things to take care of in a plane, we're going to have more troubles. If someone were to make an analysis, I think they'd find that safety is pretty much parallel to speed. Whether we like it or not, that's probably true for any form of transportation: aircraft, automobiles or anything else. I haven't seen a study of this, but if it were worked out, you'd find there's a pretty good relation between safety and speed in spite of all we do."

Leslie Neville: *"This decompression problem has been referred to as a small problem. What are the major problems?"*

W. T. Dickinson: "The major problem facing jet transports today is the problem of getting them stopped on a runway. At the moment there doesn't seem to be any answer to that. I don't mean a dry, hard, concrete runway or an asphalt one. I mean a wet, slippery, icy or snowy runway. The advent of the reversible propeller has virtually eliminated the type of accident in which the airplane plows out beyond the boundaries of the airport. The reversible propeller has been a great thing from the standpoint of saving accidents on airports. This problem of stopping the jet transport is facing the industry today and we don't know right now what the answer will be."

Leslie Neville: *"Mr. Hage, what are your thoughts on this braking problem?"*

Bob Hage: "When you say there isn't any way of braking the jet transport, you probably are thinking of it from the airline standpoint—no practical way of doing it. I think you probably are all familiar with the parachute technique used on military jets which seems to be satisfactory.

Frank Fink: "Without a doubt, to stop a jet transport you'd have to have reverse thrust. Some of the jet engine companies have been giving thought to a forward-facing bleed and burn unit on the jet engines. So far, it's just a thought. I don't believe anyone has gone through with it. You could also use forward-facing JATO, but it would probably meet the same reluctance the parachute technique meets in commercial operation because of the expense."

Leslie Neville: *"Mr. Kroon, what do the engine people think about all this?"*

R. Kroon: *(Mgr. of Engineering, Westinghouse Electric, Aviation Gas Turbine Div.):* "From the standpoint of the engine, it is entirely feasible to destroy or reverse the engine thrust. The simplest concept of a thrust destroyer is probably that of a large spoon in the jet which reverses the flow of the exhaust gases and thereby produces a negative thrust. There are a number of ways to achieve thrust reversal that look attractive for transport operations, though all of them appear to involve additional weight.

Leslie Neville: *"Can it be done with the existing types of turbojet engines?"*

R. Kroon: "It can be done with existing types of turbojet engines with suitable modifications"

Leslie Neville: *"How do the Allison people feel about it, Mr. Shields?"*

G. R. Shields: *(Asst. Zone Mgr., Allison):* "I don't know that we've made a great deal of study on the problem with jets. I frankly don't know whether our engineering department has given it a whole lot of consideration as yet."

Leslie Neville: *"Mr. Holland, what's GE thinking?"*

R. T. Holland *(Product Planning, General Electric Co.):* "At the risk of over-simplification of all these problems that are brought out, we're apt, I think, to find ourselves looking at nothing but the problems, thereby losing some of the courage that has made the airplane what it is today. As we talk of these problems, I keep thinking—what if the people who put together the fabric airplane had said, 'What will happen if we try to operate this airplane at 20,000 feet?' I am sure they would have come up with the very same fears, etc.

"Many of our major problems, such as the

LOCKHEED *was represented by Hall Hibbard (left); General Electric by Bob Holland*

one of stopping the airplane on the runway, will yield to advances in technology. As Frank Fink has mentioned, a forward-facing bleed and burn method which keeps the airplane under full control will very much reduce the landing run of an airplane. It is something which will require close coordination between engine manufacturer and the aircraft manufacturer for its application. I think it is one of the most promising solutions to the landing problem."

Leslie Neville: *"Is there any hope of getting improved fuel consumption at low speed and anything in the offing to overcome what seems to be a fundamental disadvantage?"*

R. T. Holland: "When we look at what's pushing an airplane through the air, we find it's a mass of air, either of one diameter or another. If, as in the case of the propeller, it's a mass of air of large diameter, then, obviously, its low-speed characteristics are going to be good. If it's a small diameter of air of the same mass flow that is being pushed backward, then it's going to be efficient at high speeds. I think that if you had a variable diameter propeller, you'd have the optimum. That may lead you to thoughts of ducted fans, etc. But the history of the development of propulsive devices has shown that the optimum, the best, is not always the one that turns out to be economically the best."

Leslie Neville: *"What about a combination of powerplants?"*

R. T. Holland: "We've thought of that, especially in view of the composite airplanes we've seen around. The B-36, for example, has piston engines and jets. Perhaps, if studies were made to deliberately start out on the composite airplane, maybe you'd have something. I don't know."

R. Kroon: "From an operating standpoint it seems to me that the choice of a single-type powerplant is to be preferred. To build a reliable powerplant which will be the equivalent of an engine with a variable-diameter propeller, mentioned by Mr. Shields, is going to be a difficult matter. There may be cases where it is practical to combine turboprop and turbojet. This combination can be made to provide a desirable thrust vs. speed characteristic. Such a combination, of course, has some of the disadvantages inherent in the use of turboprop. In addition, having to operate two types of powerplants results in additional complexities."

Leslie Neville: *"Has Douglas given any thoughts to combining powerplants?"*

W. T. Dickinson: "None whatever."

Hall Hibbard: "Ditto for Lockheed."

Frank Fink: "I've given no thought to combining them, except when it's by accident, like the B-36. But there is one thought that perhaps should be brought into the picture—whether it should be a pure turboprop or a turboprop that has a smaller propeller on it, putting some of the thrust into the propeller and some of it in jet thrust out the back end. This might give you higher speeds and still give you the extra thrust of the propeller for take-off and the reverse thrust for landing. In a way that's a combination engine because at high speed you're depending on a lot more jet thrust than you are with a normal turboprop."

Leslie Neville: *"What do you Boeing people think about that?"*

K. C. Gordon: "We are highly enthusiastic about doing away with propellers. We recognize there is a landing problem and we've tried things in addition to the parachute for stopping airplanes. We've developed an anti-skid device which we feel any new jet transport should have incorporated in it. We also favor spoilers on the wings that would tend to reduce your lift the minute you're on the runway and increase the efficiency of your brakes. But to get back to the composite problem, in general it is related to the landing problem in that if you put enough wing on the airplane so that you can land on any existing airport, then the take-off problem is not too severe. Again I say, if we can do the job with pure jet, we would prefer to do it that way.

"We go along with Hall Hibbard's statement that there are places where the turboprop is the most efficient. But we still think that getting away from the propeller is one of the greatest advantages of the pure jet transport."

G. R. Shields: "In line with Mr. Fink's comments and also Mr. Holland's, I think the ducted fan would come the closest to being what you might call an ideal composite type of single powerplant. Unfortunately, however, the ducted fan is just study on paper for most of us."

R. Kroon: "The ducted fan probably is an optimum powerplant for certain applications, but if you go a little bit one way or the other, the turboprop or turbojet will nose it out of the field. Therefore, from a practical standpoint, there isn't much desire to apply ducted fans."

G. R. Shields: "That's probably why the ducted fan is still in the paper stage."

R. T. Holland: "That's the point I am making—that there are considerations other than theoretical superiority that sometimes dictate the type of engine to be used. Avoiding the use of propellers, for example, may be one of these over-riding influences. This over-riding influence points to the engine which seems to be getting the most development, the turbojet."

Les Neville: *"Another question that seems*

(*Continued on page 56*)

Skyways Round Table

(*Continued from page 55*)

to be in the minds of many is the reliability of turbojet engines. Mr. Kroon, what is your viewpoint on that?"

R. P. Kroon: "Contrary to some early expectations regarding the use of axial-flow turbojet engines, the record which these engines are building up in military operations and under battle conditions in Korea is very gratifying. The availability of axial-flow engines under such difficult operations has been excellent. The engines have proved themselves capable of operation in spite of considerable battle damage. Overhaul periods are being increased to where they are comparable to piston engines.

"From anything that we can see, turbojet engines should provide dependable air transport."

G. R. Shields: "During the past six or seven years, U.S. engine manufacturers have brought the jet engine from 25 hours to 1,000 hours between major overhauls. Admittedly, 1,000-hour engines are not routine, but 500-hour engines are not uncommon in military service, and development is constantly improving average overhaul life. It is certainly reasonable to expect that jet engines will give satisfactory and dependable performance in commercial transport operations."

Les Neville: *"About how long do you think it would take to engineer, develop, build and get into production service on the airlines a jet transport Mr. Hibbard?"*

Hall Hibbard: "My rough estimate would be about six years."

Frank Fink: "I think that's a good estimate."

Les Neville: *"If it takes six years to bring out a jet transport, Mr. del Valle, is Pan American considering the purchase of the British de Havilland Comet, perhaps for interim operation?"*

Wm. del Valle: "Pan American's President, Juan Trippe, made a remark to that effect during his recent visit to England. He said, 'Pan American would buy *Comets* if business dictates it.'

"As far as American manufacturers are concerned, I don't believe they would take orders for a jet transport if they got them today."

Les Neville: *"I suppose there are certain financial risks involved in producing a prototype jet transport?"*

K. C. Gordon: "Boeing, as you may know, has been in favor of Government aid for this purpose, since the amounts now involved in the development and construction of a prototype would equal the working capital of any well-established aircraft manufacturer. It has been our philosophy that our world air supremacy is as important as our standing on the high seas which has been subsidized through the establishment of the Martime Act for a great many years. The recent launching of the 'United States' is a good example of this. This 'United States' cost some $70,000,000. However, the operating company is subsidized to the extent of some two-thirds of this cost.

"In any event, Boeing has favored some form of Government support and believes that the legislation introduced by Johnson shortly before the adjournment of the 82nd Congress in his Bill S.3473 represents a reasonable approach to the problem. I believe the Industry is behind this bill in general with the exception of Douglas who has taken a stand against any Government support for commercial aircraft development."

Frank Fink: "I think any aircraft manufacturer would be crazy to take an order from an airline to build a jet transport. However, in our American way of life, some manufacturer probably would take such an order."

Hall Hibbard: "Entirely too much is being said about all the difficulties connected with the building of a jet transport and its operations on the airlines. The problems of constructing an airplane of this type can be solved by the airplane transport manufacturer without undue difficulty. The problems connected with its operation can be solved by the airline operators without undue difficulty. We should quit talking about these problems as if they were excuses for not going ahead with the jet transport.

"The basic reason for not going ahead on a jet transport is an over-all financial problem. By 'over-all' I mean the production financing as differentiated from the prototype financing. The stakes are big both ways, but bigger stakes are involved in the production financing. I am sure, however, that a solution to this problem will be found shortly and the jet transport will then go forward."

Les Neville: *"That seems to sum up the situation, Mr. Hibbard, and perhaps on that note we ought to close this meeting."*

Wm. A. del Valle: "I'm certain everyone here joins me in thanking SKYWAYS for the opportunity to get together to talk over our particular problems. Meetings such as this are sure to be of profit to the entire industry."

At Press Time

To keep readers abreast of turboprop and turbojet transport developments in U.S., here are last-minute reports:

Boeing: Is building a prototype jet transport of new design; should be available in 1954.

Convair: Mainly interested in medium-range transports, Convair engineered the 340 for turboprop engines and it will be so equipped when those engines become commercially available.

Douglas: Now has fuselage mock-up of its DC-8 turbojet transport.

Lockheed: Is putting turboprop engines on two Super Constellations for U.S. Navy, and has had design for turbojet transport since 1950, but no mock-up.

Approved Pilots

(*Continued from page 25*)

point as their ace in the hole, was perfectly agreeable to insurance predicated upon these men? Further, was it not similarly logical for insurance to insist upon pilot clauses?

As aviation achievements became news items and famous names were on every tongue, other lesser known events and people put aviation all over the world on a business basis. Part and parcel of that business basis was consistent and sound insurance. Just as this engine and that propeller was tried, so were various ways of insuring. Failures lead to better ways and in insurance lead to firmer and firmer conviction that the pilot was one of the most important if not *the* most important turning point for the acceptance of a risk or the extension of a policy to provide even more insurance.

We do not wish to minimize in any way the advance made in aircraft design, manufacture or performance. These did certainly play their part in making insurance advance its coverages to more and more users. No one, however, has yet found the way to redesign the human being. So long as he plays the role of helmsman, technological advances help him but can never remove his tremendous potential to vary and easily negate all that has been done to help him.

In our present position in aviation, we enjoy time, place and money of a war which experimented in the unknown and taught know-how through millions of hours of experience. When discussing safety today, let's recognize that we are using this tremendous experience storehouse to fly today. Let's honor those who write restricted pilot clauses if, when they do so, they are acting as holders of the "word" from aviation records that such restriction makes sense. Let's honor aviation likewise, however, for demanding proof of competence from its would-be pilots before hiring them. Let's also honor those thinkers who see that we must keep up proficiency so that present equipment can be flown at its peak of performance, and from present efficiency the step into better planes can be made.

It is a mite embarrassing for a representative of the aviation insurance markets to hold that those markets do not play the role ascribed to them. By all that is right, though, it is too obvious to those who check that although underwriters prepare the pilot clauses, they do so *only* from the facts which aviation people themselves have compiled and acknowledge to be true. Particular instances have existed and will exist where the reading is vague, where difference of opinion will be strong and when some one is wrong. Such cases mean trading and eventual compromise. Across the board, though, pilot clauses will continue to be an important part of aviation insurance contracts in reflecting a key condition of a risks' operation and an agreeable warranty by aviation as to its ability to meet its part of the trade.

Business Plane . . .

(Continued from page 21)

left wing as the tower man said, "Cessna 31V, cleared to land, runway 31."

Mr. Geyer was in Fort Worth on time, and subsequently succeeded in making our company about $5,000. Making airline schedules and getting to Fort Worth at the necessary hour would have been impossible.

In talking about executive aircraft, most people think in terms of big corporations with dozens of vice presidents and general managers, and offices scattered all over the United States. Corporations like that can afford their own airplanes because of the tax set-up. But small business can, too.

We are a small company, and although the business airplane is deductible as a tax item, our main reason for having one is necessity. Our airplane was purchased because there was work for it; a definite need existed for a faster, more convenient mode of transportation. Our company consists of two owners, and about 20 steady employees. Although we have projects in 10 different cities, we are definitely not big business yet, but we're getting bigger all the time. We buy and sell heavy industrial machine tools, and some of the biggest plants in the country are our customers. Swift, dependable transportation and a flexible schedule are our main assets.

While attending an auction sale in Anderson, Indiana, one afternoon, we were told that a machine we'd been looking for was coming up for sale in Cincinnati that evening. Since the airplane was available, we were able to finish out the auction at Anderson and still get to Cincinnati in time to appraise the sought-after machine. Notifying the home office of our whereabouts, we were then able to stay four days, while the bosses attended other sales and searched for other hard-to-get items.

Sometime ago, I was asked if I had any idea what owning an airplane was costing Machinery Company for every hour it was flown. After a little calculating, I arrived at the answer.

The biggest factor in determining the cost of owning an airplane is, of course, the horsepower and number of engines. Someone once told me that since the larger engines consume more fuel and are more expensive to maintain, it naturally follows that cost-per-hour will go up. However, there is the seat factor to be considered, and also the average number of miles traveled in the course of an hour's flying time. The bigger twin-engine ships are slightly faster, accommodate more passengers and, therefore, if you are going to compute the cost-per-seat-mile and airplane-mile, the figures would not be much higher than those for our single-engine Cessna.

Let's take a look, dollar-wise, at what owning a Cessna 195 has meant to Machinery Company during the period from May 7, 1951 to May 7, 1952. The total cost-per-hour is broken down into two categories: operating cost and fixed cost. Fixed cost becomes lower the more the airplane is used. Operation costs tend to increase slightly as the plane gets older.

Fixed costs—including insurance, hangar, depreciation, crew wages—were found to be $9.24 per hour on the basis of 822 hours flown during the period. On this same basis, cost of operation per hour, which includes gas, oil, maintenance and repair, and landing fees, figured out at $10.05. To help keep cost down, I wash and wax the 195. If done by someone else, this item would cost around $125.00 per month.

Adding fixed and operating costs, we arrive at a total per hour of $19.29. Seem high? Well, let's go a little further and see what the 195 costs us per mile and, finally, per-seat-mile. The following figures may surprise you as much as they did me.

Assuming a conservative average groundspeed of 140, and distributing the cost over the 115,080 miles the airplane was utilized, I came up with .137¢ a mile. The cost per-seat-mile (not including the pilot's seat), was computed at .034¢! Remember, this summation is for a fast (160 mph TAS), 300-hp, single-engine five-place airplane.

Costs in detail run like this:

Gas and Oil	$3.166 per hour
Maintenance, Hangar, Fees	6.898 " "
Insurance	1.582 " "
Depreciation	2.701 " "

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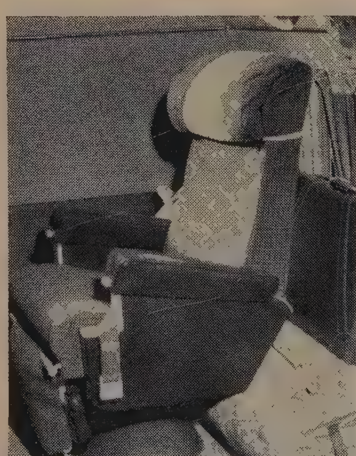
The executive plane has certainly arrived at our place—and it's here to stay.



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DC-3 with Jet Boost

(*Continued from page 15*)

Constructions Aéronautiques du Sud-Quest (or SNCASO), a company that has extensively tested a DC-3 fitted with a small Turboméca *Palas* jet unit attached to the underbelly. A comprehensive series of trials also have been carried out by the French Air Ministry who, after conducting 50 flight tests, were as enthusiastic as the originators of the scheme. The test flights were made with a machine fitted with a *Palas* unit giving a static thrust of 310 lbs. (although this unit has since been certified at 350 lbs. s.t.) and the tests proved that, under standard conditions, the increase in climb rate during the critical take-off period was 70 fpm, corresponding to an increase of 1,770 lbs, all-up weight under equal safety conditions. With the increased thrust now available from the *Palas*, this figure can be further improved, and detailed test results can be seen from the diagram on page 14.

The installation of the *Palas* booster turbine on the underbelly of the DC-3 entails an increase of only 245 lbs. in empty weight. The unit is attached to the two central ribs of the wing center section by means of three bolts, and three inspection panels are cut in the skin to allow for installation of internal equipment and subsequent maintenance. The *Palas* pod possesses its own lubricating system and operates from the same fuel as that of the piston engines, avoiding the need for the installation of special kerosene tanks. A cock is fitted in each of the four fuel tanks connecting up to a selector valve identical to those incorporated in the fuel system of each piston engine. This selector valve, which is controlled by the pilot and enables him to feed the jet from any one of the fuel tanks, also acts as a shut-off valve, enabling the fuel supply to the jet to be cut-off instantaneously in an emergency.

All the controls are electrically operated and grouped on a single panel located over the center of the instrument facade. These controls consist of a starter button, an ignition coil switch, a regulator control and the triple-indicator switch. The electrically operated indicators, grouped on a separate panel to starboard, consist of the triple-indicator (jet pipe temperature, oil pressure and oil temperature), a regulator position indicator, a fire-warning light and a revolution counter.

Maintenance is negligible when one considers that the turbojet would normally be used about 80 hours on an airplane flying approximately 1500 hours in one year, and that the life of the *Palas* is about 500 hours. Mounting or removing the *Palas* unit, once the original installation has been made, takes about one hour due to the small number of attachment bolts and electric connections.

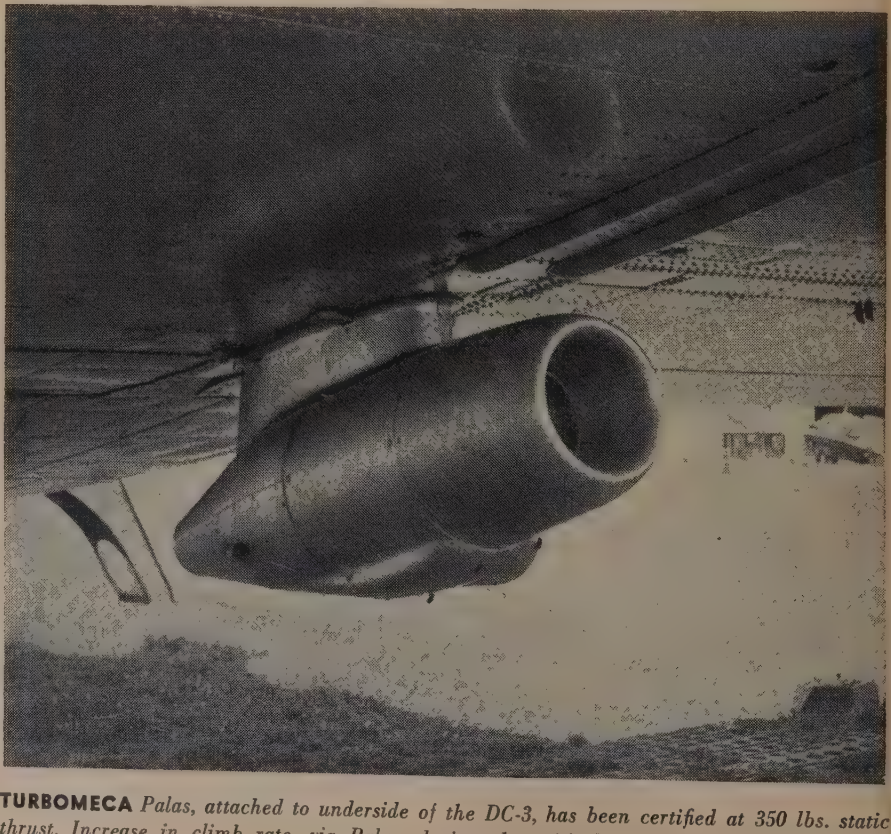
The noise produced by the *Palas* while running is not audible in the passenger cabin above the noise of the piston engines, and the operation of such assister-turbines is much less disturbing to the passenger than is that of take-off assistance rockets

The starting procedure is simple and the *Palas* takes approximately 20 seconds from starting to reach its full thrust rating. The turbine can be run normally during all take-offs, during the critical first stage of the climb and during the final approach. Otherwise, the turbine remains unused unless en route engine failure makes it necessary to start it up again in order to maintain altitude.

An annual budget chart for the utilization of a *Palas* booster pod on a DC-3 has been worked out by the SNCASO. The figures are based on current French costs. Reckoning on an average increase of five passengers per flight on a 1500-hour utilization per year with a block speed of 112 mph, the annual increase in returns (at an approximate figure of .067 cents per passenger mile) comes out at around $56,280.00. To set against this increase in returns, expenditures include: (1) Jet fuel consumption for 750 take-offs per year, 3.2 U. S. gals being used for each take-off; $840.00; (2) Additional fuel consumption of piston engines due to the drag of the *Palas* pod: $560.00; (3) Estimated annual maintenance cost: $840.00; (4) Estimated annual consumption of spares: $2,240.00; (5) Amortization *in three years* of the unit together with a complete set of spares in the most unfavorable case of a single aircraft in operation, per year: $11,200.00—Total expenditure thus amounts to approximately $15,680.00. This estimate is intentionally pessimistic as regards expenditures but, nevertheless, the advantages of the use of the *Palas* for boosting the DC-3 are immediately evident.

A number of variations on the same theme have been worked out for other aircraft, one of which envisages the installation of two Turbomeca *Marboré* II units, giving a total thrust of 1,750 lbs., installed in the rear of the engine nacelles of a large, 52,000-lb. airplane. Starting with a basic all-up weight of 52,000 lbs.—at which runway length of some 1500 yards is required to deal with engine failure accelerate-stop, or climb to 50 feet requirements under IS conditions—the use of two booster turbines allows for the same conditions—an increase in all-up weight of roughly 7,000 lbs. taking the weight of the *Marboré* units, installation and fuel reserve into account, this increase in permissible take-off weight amounts to an increase in payload or fuel load of around 5,000 lbs. In high-temperature or high-altitude conditions, the improvement in performance, although proportionately less, will be of extreme value as, under Tropical Maximum conditions, the airplane needing a runway length of 2,000 yards to deal with a take-off weight of 49,000 pounds can be flown off, with the aid of the *Marborés*, at a weight of some 55,000 lbs.—higher than would be possible with the unassisted airplane under normal temperature atmosphere conditions.

From the results of the French tests it seems certain that booster turbines such as the *Palas* can offer take-off safety in case of an engine failure, increases in service ceiling with one engine out, increased payload, increases in range and the possibility of avoiding commercially uneconomical stops, access to small airfields, and the possibility of taking off from airfields of high elevation or situated in a tropical atmosphere which would otherwise be unsuited. The idea appears to be worth examination.



TURBOMECA *Palas, attached to underside of the DC-3, has been certified at 350 lbs. static thrust. Increase in climb rate, via Palas, during the critical take-off period was 70 fpm*

Navigation NAVICOM Communication

Vol. 11 Number 11 | **November, 1952** | **Navicom Number 17**

Corporation Aircraft Find Increasing Use of VHF-FM Two-Way Company Radio

The aviation industry and especially owners of executive and utility aircraft (petroleum and pipeline operators are one example!) are becoming increasingly interested in the use of VHF-FM (Frequency Modulation) two-way radio equipment to provide communication with their company-owned ground-stations and mobile vehicles. Like the police, forestry products and land transportation services (taxicab and railroads), industries have installed two-way equipment in great quantities since the end of the war. In many cases companies which do not have their own communication system, are years behind their competitors who are almost 100% radio-equipped.

For these company applications, the Federal Communications Commission has made two principal frequency bands available, *i.e.,* 25-50 and 152-174 mc. The latter band is considered better for short-range operation (10-15 mile communication between base station and land mobiles). The lower frequencies, 25-50 mc, are better suited for greater distances, (15-50 miles with mobiles). Distances mentioned are over flat or rolling terrain. In most cases, these industries have a choice of specific frequencies in both bands, these being selected for their particular requirement; for example, for city operation the higher band is usually considered better, and for rural or country operation the 25-50 mc frequencies are said to be more suitable.

Small aircraft have proved very effective for patrolling and inspecting pipelines, telephone lines, etc. for breaks; more recently, helicopters are being tried. Many operators use their executive aircraft not only for transportation but also for patrolling, and other work jobs. These planes are equipped with VHF-FM equipment, their operators can maintain constant telephone communications with their headquarters and ground installations while in flight.

For the executive aircraft operator or pilot who is not accustomed to the use of VHF-FM (Frequency Modulation) but uses standard VHF-AM (Amplitude Modulation) aircraft equipment for normal air-to-airways and air-to-tower communications or VOR, the following may be of interest: VHF-FM, like VHF-AM (operating in the 108-132 mc aeronautical band), has a range that is approximately equal to sight; however, VHF-FM communication equipment, like VHF-FM broadcasting (88-108 mc) and the audio portion of television, is not nearly as susceptible to interference from aircraft ignition, generator noise or man-made "static" as often encountered at the ground station, as is the AM equipment. Most pilots know what a leaky ignition harness does to AM radio.

COMCO MODEL 400 VHF-FM *aircraft unit for communication between company-owned ground station and aircraft, weighs 22 lbs., complete with pilot's control box, cables, mike, etc.*

Another advantage of FM versus AM is the weight factor. Comparing an AM transmitter with an FM transmitter (designed for aircraft service) having equal transmitter output, will give the FM transmitter a considerable margin over the AM or a much greater "watts per pound" ratio. This is due to the transformers and other components required by the AM modulator and which are eliminated in the FM transmitter. Further, the AM modulator draws considerably more power from the power supply than FM. For an equivalent power supply, approximately three times as much transmitter power output can be delivered to the antenna by the FM transmitter.

For some years, the Communications Company of Coral Gables, Florida has specialized in the design and manufacture of VHF-FM two-way radio telephone equipment in accordance with customer recommendation and specifications. Their line of customized VHF-FM mobile and base station equipment has many special aeronautical applications and is used by many executive, patrol and survey aircraft operating industrially.

The 8-10 watt COMCO Model 400,

(*Continued on page 62*)

Corporation Aircraft Find Increasing Use of VHF-FM Two-Way Company Radio

(*Continued from page 61*)

designed especially for VHF-FM aircraft use, weighs approximately 20 pounds, complete. The single self-contained unit, consisting of fixed frequency, crystal-controlled receiver, transmitter and vibrator power supply, occupies a space only 13x11x5 inches. Being fixed frequency, no tuning is required, and this permits the unit to be mounted in the baggage compartment or other suitable location aboard the aircraft any distance from the cockpit. The only controls necessary for the pilot are the Off-On switch, volume control and squelch control. Either headphone or loudspeaker output can be provided. The COMCO Model 400 aircraft unit is supplied for either 12 or 24 volt battery systems. The photograph illustrates a complete aircraft package ready for installation. The specifications can be obtained from the company.

The antenna required for 152-174 mc operation aboard the aircraft consists of a quarter-wave vertical "whip" type, similar to the usual 118-132 mc two-way VHF aircraft antenna, except that it is slightly shorter, being approximately 18 inches.

The antenna for the 20-50 mc band usually presents a problem: a quarter-wave for these frequencies is 9 to 4½ feet in length. A whip type, on the high end of the band, is practical on some type of aircraft. However, for the lower end of the band, a whip is impractical and it may be necessary to use a load coil with a four to five foot whip, or a "T" or "L" type cut for a quarter-wave can be used on some planes. Attention is called to the fact that the vertical section is the portion giving useful radiation. For best results it is, therefore, necessary to use a vertical antenna (while in normal flight) to match the ground and mobile stations.

COMCO Model 400 AC equipment is also available for use as a 12 to 15 watt base or ground station. These, although comparatively low powered, provide excellent VHF-FM communication with the aircraft. The COMCO ACRO-MATCH is recommended for the VHF ground station antenna. The 10-15 AC watt models, as well as the COMCO Model 300 25-50 watt models, are available for both the 25-50 and the 152-174 mc bands.

Companies are assigned their own frequencies by the FCC for their particular class or operation, thus permitting each company to have, in effect, its own "party line." By having both the AM and FM equipment, the pilot can stand by simultaneously on both airways and his company frequency. In some executive aircraft, the FM circuit is only used by the executives or passengers.

The oldest service for which the COMCO VHF-FM aircraft unit was originally designed is the Fish and Game Commission. Several years ago, COMCO worked closely with one of these commissions in designing the original lightweight FM aircraft unit for use in small planes. These proved to be extremely effective, especially in apprehending game violators.

Another advantage to the pilot, by the use of a company radio system, is that WX reports can be obtained from the company radio stations which are often located off the airways. Flights to outlying camps can often be completed which would be questionable if local weather information was not immediately available to the pilot.

Here's a representative list of Companies using this equipment:

1. Chemical Process Company, Breckenridge, Texas. Spartan *Executive*. Pilot: H. M. Stephenson. Used to keep contact with major stations and mobile units throughout Texas, New Mexico, Oklahoma, Kansas and Louisiana.
2. The Texas Company, Producing Dept.—Louisiana Division, Houma, La. Two Grumman *Mallards* and a *Widgeon*. Pilots: C. F. Hanna and M. A. Fuori. Communicate with District Offices and drilling locations.
3. United Gas Pipe Line Co., Shreveport, La. Grumman *Mallard*. Pilots: W. C. Huddleston and L. R. Schexnaydre, Chief Pilot E. P. Jeter, Jr. Used by South Louisiana Division for correlating pipe line operation and gas supply on offshore line in the Gulf.

Nav-Aid Changes & Additions

Once again, it is desirable to stress that this department of NAVICOM is designed to spotlight vital changes in the navigational and communications facilities of the airways system—changes that might escape the notice of pilots despite publication in government and commercial airways manuals, and NOTAMS.

AUSTIN, Tex.—The Outer Compass Locator is now on 404 kc. Travis Lake Fan Marker on NW course decommissioned.

CINCINNATI, Ohio—The VOR has changed frequency to 115.6 mc.

EL PASO, Tex.—The "Center" now operates on 118.9 mc.

LEBO, Kan.—The Low-Frequency range decommissioned and converted to HW radio beacon without voice on same frequency.

MACON, Ga.—The ILS completed with addition of the Glide Path on associated channel.

MINNEAPOLIS—ILS due to resume operation after modification. The "Center" now has direct communicaton service on 120.3 and 132.3 mc.

NORFOLK, Va.—Due to difficulties of site location for VOR, the VAR on 108.7 mc has been recommissioned for an interim period.

PESCADARO, Cal.—This powerful (6,000 watts) HH-class radio beacon on 190 kc is now equipped for voice communication.

SALEM, Ore.—New ILS completed on 110.3 mc, serving Runway 31 at McNary Airport; the Middle Comlo on 215 kc. Outer Comlo on 266 kc.

SAN DIEGO, Cal.—The Barrett Lake Fan Marker on the E course of San Diego is now keying *one* dash instead of dot-dot-dash: ". . —"

TAMPA, Fla.—Approach Control tower has added 118.1 mc.

TOLEDO, O.—The old Toledo VOR has been relocated to the southwest, approximately eight miles west on W course of the re-located LF range; is now identified as "Waterville" (VWV) on same frequency temporarily without voice.

CAUTION: The low-powered LVOR on 113.6 mc, test basis, now identifies as "TOL".

WILMINGTON, Del.—Tower VHF now 120.9 mc instead of 119.9 mc, source of old conflict with LaGuardia Approach Control. Difficulties, mostly site suitability problems, have slowed the Amber Nine VAR Airway conversion on the East Coast. Whereas Atlantic City and the Salisbury conversions to VOR have been happily proven, the Norfolk site has been less happy, hence the re-commissioning of the VAR mentioned above.

During the interim period, the airway will remain VAR from North of Charleston, S. C. to Norfolk and an intersection of the new Salisbury VOR SW-NE Radial and thence by way of Salisbury and Atlantic City VOR's to Matawan VAR.

(*Continued on page 64*)

Air Traffic Control Group Meeting at Washington

During August of this year, the CAA brought together in Washington, one of the most unusual groups of experts to ever assemble in that mecca of officialdom. Unusual, because these were really experts, the men in the field who work every day with the problems of air navigation, traffic control and facilities all over the seven domestic Regions of CAA, Alaska and Honolulu, as well as the Washington home staff.

The results, as submitted to the Traffic Control Procedures Section of the Air Traffic Control Division, Operations Branch, CAA by C. P. Burton, Chief, Washington office of the Airways Operations Division, are important to every pilot, professional or otherwise, so long confounded by the complexities of our ever more complicated airways systems.

Pilots who have had to listen in the past to interminable ATC clearances at machine-gun speed will appreciate the increasing emphasis CAA has been putting on abbreviating them to the bone with Radar short clearances, etc. Hence, it is no surprise that the working group of ATC controllers, equally irked at the old way of things, has recommended that in the future, such phrases as "ATC clear - - -," "ATC advises - - -," and "No delay expected!" be deleted. Inasmuch as ATC is the only body from which such clearances issue anyway, it will be a relief to not be everlastingly reminded of it when trying to copy an ATC clearance in the middle of a run-up check. Similarly, either because no delay is mentioned or because a pilot gets to figure some delay is inevitable on IFR these days, the "No delay" phrase has lost meaning.

In lieu of the practice of repeating back the entire route of a long IFR cross-country flight plan, it was suggested that when a pilot's route as filed is approved in his clearance, the simple statement "Route as filed" is adequate. And if not approved as filed, the itemized listing of the ATC-suggested revised routing will stand out more obviously.

The phrase "request further altitude change en route" was challenged. Minimum instrument altitudes, clearances at altitudes other than as filed to expedite departure, radio failure procedures, all operate to cover the problem supposedly referred to by this phrase and hence, it is expected that a pilot is not going to have to be prodded into reminding ATC that he filed one altitude and he was compelled to accept another to get going.

Pilots can rejoice in the knowledge that they are not alone in rejecting the new phon (y)-etic alphabet. The controllers universally recommended that they be relieved of the unique status of being the only unfortunates of the airways officially compelled to use it.

Less popular if it involves pilots operations as well, will be the recommendation that Greenwich Mean time be adopted as the universal standard for all operations.

A popular rumor has it that most pilots for many reasons, good or bad, never see most NOTAM's (Notices to Airmen) and are even less interested in doing so.

For years, the gobbledegook in fine print has been becoming more obscure every day. The coded contractions have increasingly resembled a private secret code and the multiplicity of items has confounded even the most diligent pilot. (NAVICOM's section on "Nav-Aid Changes" developed from this fact!)

So the controllers have recommended that the system be revised with an eye to simplification, reduction to basic essential categories, avoidance of code and return to plain old-fashioned English. In other words, a language familiar to pilots.

They also recommended that the CAA delay acceptance of VOR track separation on IFR airways flying at the same altitude. In the light of the fact that an alarming proportion of the VOR's in the country are on NOTAMs because of unreliable course indications, this is a very commendable suggestion. The low-frequency airways will be with us for a while.

Of interest to those pilots who, on IFR plan through intermittent or marginal IFR conditions, have met the VFR pilots inevitably present, will be the recommendation that all VFR traffic on the airways be asked to operate at 500 feet above the recommended directional altitude and well to the right. This may not solve anything, but it indicates healthy concern for the problem.

It was also suggested that it be required, by revision to Civil Air Regulation, that a pilot must advise of any substantial deviation from his filed TAS (True Air Speed) regardless of time extent or reason. There have been some close ones where pilots have slowed up on instruments because of storms, with the result that following aircraft on the airway at their altitude have closed the required time gap between them.

Few professional pilots other than scheduled airline pilots ever get to see an old stand-by of ATC—the "Operations Letter". This "letter" was a proposed and approved standard operating procedure for any particular ATC facility, governing the handling of aircraft by and at that facility. If the recommendation made at Washington is followed,

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Air Traffic Control Group Meeting at Washington

(*Continued from page 63*)

these will be replaced by "Letters of Agreement" *between agencies* and will not be distributed to "other disinterested parties"!

Aside from the fact that sometimes it is better not to know of the procedures contained in such "letters" (or you would cancel flight outside the area concerned), there is such a thing as having some advance information on what will be expected of you at a busy terminal area. This could make the jolt a lot softer when you get a routing or handling which bears no resemblance to what you planned.

A modern step, in line with the higher performance of IFR traffic on the airways, is the suggestion to revise the familiar "five/on top" (five hundred feet above the overcast) rule to at least 1,000 feet. It should not have to be a regulation before a pilot realizes that if he persists in skimming the tops of any overcast, scattered or broken or solid, without a definite altitude assignment and separation, that he is liable to get himself a high colonic from a fast climbing airliner busting out on top with an IFR clearance.

A subject dear to the hearts of many controllers in busy terminal areas is the inadequacy of present VFR standards with the increasing approach speeds of modern aircraft. Maybe three miles is enough along the airways *if* everybody is on the right side, at the recommended altitudes, etc. But every day, more professional and experienced non-professional pilots are beginning to agree that some revision of that standard is indicated where convergence of airways to a heavy traffic terminal increases the air saturation to the point where head-on closing speeds of 300 mph scream of potential disaster. Maybe local and limited increases in VFR requirements in such areas, necessarily funneling traffic into controlled and separated paths and patterns, is not the best or entire answer. But it is certainly worth trying.

One of the most efficient innovations in IFR traffic control has been the direct contact with the Air Route Center. Virtually all scheduled airline aircraft possess the multi-channel VHF's necessary to cope with all frequencies called for. This is not always so with the corporation or executive or other aircraft on IFR plan. Not only does this fact deny the pilot the privilege of such expeditious handling, but it delays the operations of the Center controller who must wait for the delayed, repetitious relay of control messages via the INSAC or Airways Communications Stations.

Therefore, it was suggested that the CAA devise a means of enabling the Center controller, through the interphone facilities common to both, to use the INSAC radio for direct communication with the pilot. This is a real step in the favor of the instrument pilot who lacks the multi-million dollar facilities of the big airlines.

The report also asks for more homing facilities in congested areas for easier holding patterns and airways crossings, increased use of Radar, easement of the restrictions on runway operation separation on present day and future very long runways, and on non-converging runways.

Possible use of continuous signal or voice identification for tuning purpose on tower frequencies to eliminate delay and tuning counts is under test on Markers and Compass Locator stations (Comlos). Controllers think it might work for towers.

The last suggestion in the report recommended that the program for duplex—or cross-channel VHF—be expedited to relieve the growing congestion on simple VHF.

Initial Dilemma

A generation ago, when the government started the practice of creating agencies and bureaus so fast they had to resort to initials to identify them, it became a subject for many a second-rate comedian. Now, it seems, we have acquired in the aviation industry a similar set of initial contractions to describe facilities, operational procedures, navigational and communication aids and air traffic rules. In the interests of those who are not familiar with the abbreviations and initials, NAVICOM will occasionally, starting herewith, offer a short glossary of definitions.

GCA—Ground Controlled Approach.

ASR—Airport Surveillance Radar (Search Scope to you GI's) and PAR—Precision Approach Radar (Final approach).

INSAC—Interstate Airways Communications station (old name "Radio")

TOWSAC—Combined tower and INSAC.

FAWS—Flight Advisory Weather Service (Forecaster).

COMLO—Compass Locator station (very low-powered homing beacon associated with ILS Outer and Middle markers usually).

ILS—Instrument Landing System (Localizer Course and Glide Path).

TOWER—When used in air-to-ground communications, usually means the Local or Runway Controller who handles take-off and landing traffic under VFR in a limited radius.

Approach Control—The "laddering-down" portion of over-all tower control; works all approaching aircraft outside of the tower radius but basically concerned with traffic on IFR let-down in holding stacks and on final approach.

Ground Control—Handles all aircraft and vehicles on ground, after leaving landing runway and prior to taking take-off position. Delivers and checks ATC clearances.

ATC—Air Traffic Clearance—for approving flight at a specific level via specific airways to a destination or prescribed limit. Used to mean same as—

ARTC—Air Route Traffic Control Center. On the basis of available airspace, airways route and altitudes and time, approves IFR flight plan for flight along the airways to destination, applying certain basic separation procedures between aircraft.

Departure Control—By use of Radar, or "laddering up" and other procedures, functions to expedite departure of IFR traffic onto the airways where ARTC takes over and continues flight separation on basic separation procedures.

Nav-Aids

(*Continued from page 62*)

Following are important last-minute changes and/or additions to add to earlier-reported Nav-Aids (*page 62*):

ATLANTIC CITY—The new VORW will be on 113.4 mc, not on 116.7 as previously announced. *CAUTION: Tune this one aurally, as there are three stations within three-tenths megacycles within less than 200 miles!*

CHICAGO, Ill.—O'Hare Airport ILS scheduled to resume Nov. 1. Tower facility at Meigs scheduled to go off air Nov. 7.

DENVER, Col.—New BVOR frequency announced, 116.3 mc.

NEWARK, NJ—Should definitely resume operation IFR on or about Nov. 1, on new ILS runway approaching over the Newark Bay swamp area.

SALISBURY, Md.—The VAR due to shut-down, being replaced by the BVOR on 117.1 mc, not 117.7 as published in ANRA section of the Air Guide.

WHEELING, WVA.—The VAR due to shut-down, no replacement facility announced, but a new MHW at the Clinton intersection, frequency probably 293 kc serving the Northwest course of Pittsburgh. This leaves a gap on the two best North-South bypass routes west of PIT.

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